INSTRUCTION MANUAL

MODEL 74A

TIME JITTER METER

SERIAL NO. _____

Preliminary

HLI

HEKIMIAN LABORATORIES, INC.

15825 SHADY GROVE ROAD

ROCKVILLE, MARYLAND 20850 USA

PRELIMINARY

INSTRUCTION MANUAL
MODEL 74A
TIME JITTER METER

SERIAL NO. _____

MANUFACTURED BY

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CONTENTS

Section			Page
1.0	INTRODUCTION		1-1
	1.1	GENERAL DESCRIPTION	1-1
	1.2	SPECIFICATIONS	1-1
2.0	INSTALLATION		2-1
	2.1	GENERAL	2-1
	2.2	RACK UNIT INSTALLATION	2-1
	2.3	PORTABLE UNIT INSTALLATION	2-2
3.0	OPERATION		3-1
	3.1	GENERAL	3-1
	3.2	CONTROLS AND INDICATORS	3-1
	3.3	OPERATING PROCEDURES	3-2
4.0	THEORY OF OPERATION		4-1
	4.1	GENERAL	4-1
	4.2	DETAILED CIRCUIT OPERATION	4-2
		4.2.1 INPUT AMPLIFIER	4-2
		4.2.2 FIRST MIXER AND L.O.'S	4-2
		4.2.3 FIRST IF FILTERS	4-2
		4.2.4 LIMITER	4-3
		4.2.5 DIVIDERS	4-3
		4.2.6 SECOND MIXER AND L.O.'S	4-3
		4.2.7 SECOND IF OUTPUT AMPLIFIER	4-4
		4.2.8 PHASE DETECTOR	4-4
		4.2.9 PULSE SHAPING CIRCUITS	4-4
		4.2.10 LOCK DETECTOR	4-5
		4.2.11 PLL 10 KHZ FILTER	4-5
		4.2.12 LOOP INTEGRATOR	4-5
		4.2.13 VOLTAGE CONTROLLED OSCILLATOR	4-6
		4.2.14 ABSOLUTE VALUE/METERING CIRCUIT	4-6
		4.2.15 HIT DETECTOR	4-6
		4.2.16 JITTER OUTPUT AMPLIFIER	4-7

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Section				Page
	4.2.17	METER		4-7
	4.2.18	TIMER		4-7
	4.2.19	HIT COUNTER		4-7
	4.2.20	+5V/+200V POWER SUPPLY		4-8
	4.2.21	15V POWER SUPPLY		4-8
	4.2.22	220VAC/110VAC LINE OPTION		4-9
5.0	MAINTENANCE AND CALIBRATION			5-1
	5.1	MAINTENANCE PHILOSOPHY		5-1
	5.2	PREVENTIVE MAINTENANCE		5-1
	5.2.1	GENERAL		5-1
	5.2.2	ACQUISITION CHECK		5-1
	5.2.3	RATE SELECTOR CHECK		5-1
	5.2.4	RANGE SELECTOR CHECK		5-2
	5.2.5	HIT COUNTER/JITTER OUTPUT CHECK		5-2
	5.2.6	CAUTION INDICATOR CHECK		5-2
	5.3	CORRECTIVE MAINTENANCE		5-2
	5.3.1	TROUBLE SHOOTING		5-2
	5.3.2	SYMPTOM ANALYSIS		5-3
	5.3.3	CIRCUIT LEVEL TROUBLE SHOOTING		5-3
		5.3.3.1	FIRST MIXER/LIMITER	5-5
		5.3.3.2	RANGE DIVIDERS	5-5
		5.3.3.3	SECOND MIXER/OUTPUT AMPLIFIER	5-7
		5.3.3.4	VCO/PHASE DETECTOR	5-7
		5.3.3.5	LOCK DETECTOR	5-8
		5.3.3.6	10 KHZ LOOP FILTER	5-8
		5.3.3.7	LOOP INTEGRATOR	5-8
		5.3.3.8	ABSOLUTE VALUE CIRCUIT	5-9
		5.3.3.9	METERING/DETECTOR AMPLIFIER	5-9
		5.3.3.10	HIT DETECTOR	5-9
		5.3.3.11	OUTPUT AMPLIFIER	5-9

Section			Page
5.3.4	CALIBRATION		5-9
	5.3.4.1	FIRST LOCAL OSCILLATORS	5-10
	5.3.4.2	SECOND LOCAL OSCILLATORS	5-10
	5.3.4.3	PHASE DETECTOR OFFSET	5-11
	5.3.4.4	VCO ADJUSTMENT	5-11
	5.3.4.5	HIT AND JITTER OFFSETS	5-11
	5.3.4.6	JITTER METER CALIBRATION	5-11

TABLES

TABLE		PAGE
1-1	GENERAL SPECIFICATIONS	1-2
1-2	DETAILED SPECIFICATIONS	1-3
3-1	CONTROLS AND INDICATORS	3-1
5-1	MAINTENANCE TEST EQUIPMENT	5-3
5-2	SYMPTOM ANALYSIS	5-4
5-3	MAIN FRAME PARTS LIST	
5-5	HLI 74-300 BOARD PARTS LIST	
5-6	HLI 74-400 BOARD PARTS LIST	
5-7	POWER SUPPLY PARTS LIST	

ILLUSTRATIONS

FIGURE		PAGE
4-1	MODEL 74A BLOCK DIAGRAM	4-10
5-1	TP-4, .03 RANGE WAVEFORM	5-5
5-2	TP-4, 0.1 RANGE WAVEFORM	5-6
5-3	TP-4, 0.3 RANGE WAVEFORM	5-6
5-4	TP-4, 1.0 RANGE WAVEFORM	5-6
5-5	TP-3 WAVEFORM	5-7
5-6	MAIN FRAME SCHEMATIC DIAGRAM	
5-7	NOT USED	
5-8	NOT USED	
5-9	HLI 74-300 COMPONENT LAYOUT	
5-10	HLI 74-300 SCHEMATIC DIAGRAM	
5-11	HLI 74-400 COMPONENT LAYOUT	
5-12	HLI 74-400 SCHEMATIC DIAGRAM	
5-13	HLI 74-500 COMPONENT LAYOUT	
5-14	HLI 74-500 SCHEMATIC DIAGRAM	

SECTION 1.0
INTRODUCTION

1.1 GENERAL DESCRIPTION

The Model 74A Time Jitter Meter is designed to measure the RMS value of transition jitter on a digital data clock signal. This parameter is an important measure of both digital equipment and transmission system performance. The ability to measure and isolate sources of excessive transition jitter is an important and necessary function in maintaining a high grade of overall performance.

The Model 74A Time Jitter Meter measures RMS phase jitter and phase hits. Jitter is displayed on a multi-range meter with a 10 Hz low frequency weighting characteristic. Phase hits which exceed an adjustable threshold level are accumulated on an internal electronic counter and a timer is provided to allow hit measurement over intervals of up to one hour. A variety of operating clock rates from 4.8 kilobits to 21.504 megabits can be accommodated. Frequencies up to 150 MHz can be provided on special order. A caution lamp alerts the operator to improper instrument operation and a demodulated jitter output is provided for recording, observation of the phase jitter waveform, or spectral analysis.

The Model 74A is self contained and is 17" wide, 5-1/4" high and 14" deep. It may be rack mounted using optional rack mounting adapters and a portable cover is also available.

1.2 SPECIFICATIONS

The general electrical and mechanical specifications for the Model 74A Time Jitter Meter are contained in Table 1-1. The detailed specifications for the specific instrument covered by this manual are contained in Table 1-2.

TABLE 1-1

GENERAL SPECIFICATIONS

INPUT	
Frequencies	Up to 9 user specified frequencies between 4.8 kHz and 21.504 MHz
Level	1 v p-p minimum
Impedance	Refer to Table 1-2
METER	
Range-Bits	
3.0	3 bits (1080° rms) full scale
1.0	1 bit (360° rms) full scale
0.3	.3 bits (108° rms) full scale
0.1	.1 bit (36° rms) full scale
.03	.03 bits (10.8° rms) full scale
ACCURACY	±5% of full scale
RESIDUAL JITTER	.005 bits rms maximum
ACQUISITION (PHASE LOCKED LOOP)	±2 kHz
METERING BANDWIDTH	10 Hz to 10 kHz
JITTER OUTPUT	
Level	2.4 v p-p for 7 x full scale
Impedance	600 Ω
PHASE HITS COUNTER	
Threshold Levels (peak)	Continuously adjustable between 2 x and 7 x full scale
Count Rate	Up to 100,000 per second
TIMER	0-60 minutes
TEMPERATURE RANGE	
Operating	+10 to +40° C
Storage	-15 to 55° C
VOLTAGE	220 or 110 VAC (50-60 Hz)
POWER	40 watts
DIMENSIONS	5-1/4" High x 17" Wide x 14" Deep
WEIGHT	24 lbs.

TABLE 1-2

DETAILED SPECIFICATIONS

SERIAL NO. _____

INPUT FREQUENCIES		1st L.O. CRYSTAL FREQUENCIES	
F_1 -	_____	X301 -	_____
F_2 -	_____	X302 -	_____
F_3 -	_____	X303 -	_____
F_4 -	_____	X304 -	_____
F_5 -	_____	X305 -	_____
F_6 -	_____	X306 -	_____
F_7 -	_____	X307 -	_____
F_8 -	_____	X308 -	_____
F_9 -	_____	X309 -	_____

INPUT IMPEDANCES

SECTION 2.0
INSTALLATION

2.1 GENERAL

The Model 74A Time Jitter Meter was designed for ease of operation and installation. After the unit has been removed from its shipping container perform a complete external visual inspection for possible damage. Remove the six screws holding the top and bottom covers to expose the inner assembly. Any damage due to shipping should be immediately reported to the shipping agency.

All internal adjustments have been set at the factory and no further adjustment is required prior to installation or use of the equipment.

Primary power is supplied through the line cord which is attached to the rear panel mounted a.c. receptacle. The rear panel mounted primary voltage selector switch should be set to the proper operating voltage.

Signal input/output leads are connected to the front panel coaxial connectors. Shielded cable is recommended for all input/output connections. All ground terminals are floating with respect to chassis ground and care should be used when connecting interface cables to insure that a proper ground configuration is maintained. Chassis ground is available on the metal chassis ground binding post located in the lower right corner of the front panel.

2.2 RACK UNIT INSTALLATION

For mounting in standard 19" wide relay racks optional rack shelf adapters are available. These ears are mounted under the cover attachment screws located on each side of the unit. The unit occupies standard 5 1/4" high rack panel height.

2.3 PORTABLE UNIT INSTALLATION

For portable applications a removable cover is provided. This cover is attached with two latch assemblies to the side panels.

Power cords, interface cords and manuals are stored in the cover during transit.

SECTION 3.0

OPERATION

3.1 GENERAL

This section contains a description of the controls and indicators, and operating procedures used with the Model 74A. Prior to operation be sure that all connections to the instrument are made in accordance with the instructions of Section 2.0 Installation.

3.2 CONTROLS AND INDICATORS

The controls and indicators used in operating the Model 74A are described in Table 3-1. All controls are located on the front panel. No internal adjustments are required during normal operation. Adjustment procedures for internal controls are contained in Section 5.0, Maintenance and Calibration.

TABLE 3-1

CONTROLS AND INDICATORS

Designation	Function
POWER switch and lamp	Applies ac primary power to the unit.
CAUTION lamp	Indicates input clock rate is outside selected operating range of the instrument.
KILOBIT/MEGABIT rate selector switch	Selects the operating clock rate.
CHASSIS GND binding post	Provides a connection to chassis.
PHASE JITTER meter	Displays the rms value of the phase jitter.
RANGE-BITS selector switch	Selects the range of jitter displayed on the phase jitter meter.
HIT TIMER control	Provides timed hit measurements of up to 60 minutes duration, with hold feature.

Designation	Function
HIT THRESHOLD control	Sets the threshold level at the indicated multiple of the selected RANGE-BIT switch.
RESET readout display	Accumulates phase hit occurrences up to 9999 events.
Primary power voltage selection switch	Located on rear panel, this switch selects 220 or 110 volt ac operation.

3.3 OPERATING PROCEDURES

This section presents the measurement procedures used with the Model 74A Time Jitter Meter.

The input signal is connected to the input connector. A standard BNC coaxial connector is used for the input.

Some input signals are terminated by connecting an appropriate load to the output connector. In applications where the clock signals must be used elsewhere, a "turn around" of the input signal is available at the OUT connector for use in other equipment. See Table 1-2, Detailed Specifications, for a listing of the pertinent input frequencies.

A front panel CAUTION lamp lights when the input rate is incorrect or outside the operating range of the selected rate. The CAUTION light must be extinguished before a valid jitter measurement can be made. The rms value of the jitter is displayed on the jitter meter. The range is selected by the RANGE-BITS pushbutton switches. The range which provides the highest "on-scale" reading should be used for the jitter measurement. When using the .03 bits rms range, the yellow region on the meter scale represents the area of possible residual jitter due to the instrument itself.

The Model 74A measures the jitter energy between 10 Hz and 10 kHz.

The hits circuitry uses a four digit electronic counter to accumulate hit occurrences. This counter is reset by the front panel RESET pushbutton and the hit threshold level is adjusted using the continuously variable threshold control. The control range is set

by the RANGE-BITS switch and is calibrated in multiples of the range setting. For example if the 1.0 bit range is selected, the thresholds are respectively two bits, three bits, four bits, five bits, six bits and seven bits. The timer is used to control the hit measurement interval and periods up to 60 minutes may be selected. A HOLD position is provided for continuous counter operation.

For periods of less than 10 minutes the timer knob should be turned past the 10 minute point and then reset to the shorter duration. The timer must never be moved directly between HOLD and 0.

The JITTER jack provides a demodulated replica of the jitter waveform and may be used for observing this information on an oscilliscope or recording on magnetic tape for later use with the HLI Model 75 Dynamic Jitter Simulator.

SECTION 4.0
THEORY OF OPERATION

4.1 GENERAL

The block diagram of a Model 74A having the standard range of input clock rates is shown in Figure 4-1. The measurement technique makes use of a heterodyne, filter and divide technique to provide jitter measurement extending over multiple bits. Following this "processing", a conventional phase lock loop is used to detect the jitter and is followed by weighting filter, hit detection and metering circuits. When optional features are supplied, they are covered in their specific appendix.

The input accepts clock signals in accordance with the input specifications. The input signal is applied to the first mixer circuit which heterodynes the signal to a 10.7 MHz first intermediate frequency. Narrow band filters are then used to extract the basic clock frequency with its timing jitter. The filtered signal is applied to a zero crossing input limiter which feeds the divider circuits which divide both the data rate and its associated jitter by 1, 3, 10, 30, and 100. These signals, selected by the meter range switch, provide the input to the second mixer where it is heterodyned to the second IF frequency of 107 kHz.

The 107 kHz second IF signal is then applied to the phase lock loop phase detector. This loop consists of a phase detector, a 10 kHz low pass filter, a loop integrating filter and a voltage controlled oscillator. This circuit provides a phase stable reference against which the incoming phase variations are measured. The 10 kHz low pass filter and loop integrating filter determine the frequency band over which the jitter energy is detected. The output of this circuit is followed by an absolute value amplifier and rms detector which drives the rms phase jitter meter. It also feeds the variable threshold hit detector and counter circuit which are controlled by the one hour timer.

A variety of power supply voltages are furnished to operate the analog and digital circuitry.

4.2 DETAILED CIRCUIT OPERATION

4.2.1 INPUT AMPLIFIER

The preconditioner board input is at 300Y. The input is amplified by the differential pair Q310 and Q311 and applied to the first mixer Z301.

4.2.2. FIRST MIXER AND L.O.'S

The first mixer (Z301) is used to heterodyne the input to 10.7 MHz (1st IF). The signal input is at Z301-12 and the local oscillator input is at Z301-4. There are nine, crystal controlled, first local oscillators, one is used for each of the nine possible input frequencies. The oscillators are turned on or off by applying or removing power. As an example, if the input frequency is F_1, then +15V is applied to 300U and -15V to 300 T, S, R, Q, P, O, M, N. This enables Q301 to oscillate since Q302-Q309 cannot conduct. Q301 is used as a source follower, with capacitors C313, C314 and C315 providing voltage gain from source to gate. The oscillation frequency is set by the tank formed by X301 and the capacitors and the amplitude is limited by D302 and D303. The quiecent current used by Q301 also turns diode switch D304 on connecting this oscillator to the buffer Q312.

4.2.3 FIRST IF FILTERS

The first IF filters Y301 and Y302 are used to remove the image and local oscillator frequencies from the 10.7 MHz IF signal. The filters are narrow band crystal type with 20 kHz (Y301) as the normal or main bandwidth. The 6 kHz filter (Y302) is provided for the input frequencies of less than 19.2 kHz since the local oscillator for

these frequencies would fall in band on the 20 kHz filter causing erroneous jitter measurements. The filters are automatically selected by the KILOBIT/MEGABIT rate selector switch. As an example, if the F_1 frequency is less than 19.2 kHz, then D337 will be connected to the N (narrow) buss and the +15V applied to 200U turns on Q335 and Q337, and pull down R385 turns off Q314 and Q336 so that Y301 is disabled while Y302 is enabled. Q313 provides drive for a buffered test point.

4.2.4 LIMITER

The limiter (Z302 and Q331, 332) provides drive for the second mixer and the divider circuits. Z302 is an integrated limiter/mixer with only the limiter section being used. The input is Z302-4 and the output is Z302-10 which drives differential amplifier Q331/Q332.

4.2.5 DIVIDERS

The ranging division is provided by T^2L binaries using three integrated circuits Z303, Z304 and Z305. On the .03 RANGE the divider is one, therefore Q322 is turned on so that the limiter feeds the second mixer (Z306-12) directly. On the 0.1 RANGE the divider is 3, this is provided by turning on Q321 and Q325 utilizing Z305 which is set up for divide by 3. Z303 and Z304 are each set up for divide by 10. On the 0.3 RANGE divide by 10 is required, therefore Q320 is turned on. On the 1.0 RANGE divide by 30 is required, therefore Q326 and Q321 are turned on so that the output of Z303 (÷ by 10) goes to the input of Z305 (÷ 3). On the 3.0 RANGE the divide by 100 output is obtained at Z304-5. Q329 is used as an inverter.

4.2.6 SECOND MIXER AND L.O.'S

The second mixer (Z306) is used to heterodyne the divided frequencies to 107 kHz (the second IF). The signal input is at Z306-12 and the local oscillator input is at Z306-4. The four second

local oscillators consist of Q316, 317, 318 and 319, using the same circuit and switching arrangement as the first local oscillators (Section 4.2.9).

4.2.7 SECOND IF OUTPUT AMPLIFIER

The second IF output amplifier consists of Q334, a common emitter stage with input and output filtering to reject the second local oscillator and harmonics of the signal. This stage gets its input from either the second mixer through series switch Q323 or from the divide by 100 circuit through series switch Q324. Q330 is an inverter that is used to turn off Q323 when the 3.0 RANGE is used. The signal output is at 300E.

4.2.8 PHASE DETECTOR

The phase detector (1/2 of Z401) provides an output voltage proportional to the phase difference (phase error) between the input signal and the voltage controlled oscillator (VCO). The VCO is controlled by the average phase of the input signal. The phase detector is a set/reset flip-flop driven by pulse shaping circuits Q401, 402 and Q403, 404. The point called zero phase error corresponds to the signal and the VCO having 180° phase difference. The positive transition of the VCO "sets a one" (+5V) at the phase detector output (Z401-3), then 1/2 cycle later the signal "resets" (OV) the output so that with zero phase error the output is a 107 kHz square-wave with 50% duty cycle. Phase jitter then can be thought of as modulating the duty cycle about 50%.

4.2.9 PULSE SHAPING CIRCUITS

As mentioned in Section 4.2.8, the phase detector is driven by two pulse circuits Q401, 402 and Q403 and 404. Q401 functions to "square-up" the signal and Q402 functions to provide a narrow pulse for every positive transition of the input signal. Q403 and 404

provide the same process for the VCO. The +5V supply for the pulse circuitry is furnished by R402 and zener diode D401.

4.2.10 LOCK DETECTOR

The lock detector functions to put the phase locked loop in acquisition mode when the VCO is not "locked" to the signal. The detector consists of 1/4 of Z401, 1/2 of Z402, and Q424. Z401 Pin 11, 12, 13 is a two input NOR Gate that is driven from the "squared-up" (See 4.2.16) signal and VCO. With a condition of lock and neglegible phase jitter the signal and VCO are 180° out of phase, therefore the output (Z401-11) remains a "zero". Jitter or out of lock condition cause a "one" to appear during the time that both the VCO and the signal are low. The average level (Z401-11) is used to trigger an op amp threshold circuit Z402 (5,6,7). When lock is broken Z402-7 goes high putting the loop in acquisition mode, after about .3 sec in this mode Q424 is pulsed on to reset the averaging circuit (R415, D404 and C449). If "lock" was established during acquisition mode this is the end of the acquisition process - if not the process will automatically continue until "lock" occurs or the signal is removed. During acquisition mode Q418 is turned on lighting the caution lamp.

4.2.11 PLL 10 KHZ FILTER

The 10 kHz filter (Z402(1,2,3)) functions to set the upper cutoff on the measurement bandwidth, and to average the phase detector voltage. The input is the phase detector output and the output appears at Z402-1 (TP-2). R429 is an offset trim adjustment which is used to make the dc level at TP-2 zero volts for a 50% duty cycle at the phase detector output.

4.2.12 LOOP INTEGRATOR

The loop integrator (Z409) further averages the phase error voltage so that voltage controlled oscillator will not "track out"

the phase jitter to be measured while maintaining negligible static phase error due to input frequency offset. The integrator time constant determines the low frequency cutoff of the measured band.

In acquisition mode Q425 and Q411 are turned on and Q412 is turned off so that the control current goes through R4109 and R4110 simultaneously bringing the VCO to the correct frequency and the charge on C411, C442 to the correct level.

4.2.13 VOLTAGE CONTROLLED OSCILLATOR

The VCO (Z405) is controlled by the voltage applied to a voltage variable capacitance diode D408. The output is at Z405-1.

4.2.14 ABSOLUTE VALUE/METERING CIRCUIT

The absolute value circuit (Z406) is used so that a single positive threshold can be used to detect phase hits with either polarity. The input current goes through R468 and the output is available at Z406-7. For negative levels at TP-2, D412 conducts, D411 does not, utilizing amplifier Z406 (5,6,7) in non-inverting mode (the inverting input is maintained at virtual ground). For positive levels at TP-2, D411 conducts so that Z406 (5,6,7) now is an inverting stage. R4132 is an offset adjustment.

The absolute value circuit drives the meter detector circuit Z407 (1,2,3) and Z408 (1,2,3). Z407 (1,2,3) is used to "idealize" D417 which is used to charge C440. The ratio of R485 and R488 have been adjusted so that for a given level (rms) at TP-2 of either sinewave or Gaussian Variate the voltage at Z408-1 is the same (therefore the meter reading is the same). R494 is the meter fullscale adjustment and R493 is a meter offset adjustment.

4.2.15 HIT DETECTOR

The hit detector Z407 (5,6,7) and Q405, 406, 422, 423 is triggered each time phase jitter peaks exceed an adjustable threshold

level. Z407 (5,6,7) provides a trigger circuit that fires when the hit threshold has been exceeded. The input is the output of the absolute value circuit and the threshold set voltage at 400I from the front panel (Q423 is an emitter follower stage). During a hit Z407-6 is positive with respect to Z407-5 so that Z407-7 goes negative turning off Q405 so that level at 400J makes a negative transition. 400J feeds the input of the hit counter and the negative transition causes the counter to update. Q422 is used to disable Q406 preventing the counter from "rolling over" when the count reaches 9,999.

4.2.16 JITTER OUTPUT AMPLIFIER

The jitter output jack provides a buffered output proportional to the phase jitter. The buffer Z410 (5,6,7) gets its input from the 10 kHz jitter (Z402-1) and provides a 600Ω output at 400S. R4125 is an offset adjustment for the output.

4.2.17 METER

The jitter meter is a front panel mounted 50 microamper meter. The meter input is at 400H.

4.2.18 TIMER

The mechanical timer provides a switch that opens the circuit between the hit detector and the counter at the end of the set interval preventing further accumulation of hits.

4.2.19 HIT COUNTER

The hit counter consists of four (decade) counters, sixteen (2 input) AND Gates, four (seven segment) decoder/drivers, and four (seven segment) displays. The counters utilizes a 8-4-2-1 BCD sequence which directly drives the decoder/drivers. The 16 AND Gates provide a buffered BCD output that can be strobed. This BCD output is used as feedback to the hit detector to stop the count when 9,999

is reached. Further details appear in the appendix (Minidigit Counter/ Display Module).

4.2.20 +5V/+200V POWER SUPPLY

The +5 volt/+200 volt supply is a KELTRON CORPORATION PS2G. The +5 volt is used for T^2L circuits in the counter and on PCB-300, and for interface and driver circuitry on PCB-200. The +200V supply is used only for the counter displays.

4.2.21 ±15V POWER SUPPLY

A dual tracking +15 and -15 volt DC power supply is utilized in this instrument. It provides .01% line and .05% load regulation, and has a temperature coefficient of .02% per degree C. Noise and ripple on the power supply output are 4.0 millivolt rms maximum. Current capacity is 200 milliamperes for each supply voltage. The unregulated 28 volt DC power supply for indicator lamps is also provided by the power supply board.

The power supply is controlled by the front panel on-off push switch S101. A 1/2 slow-blow fuse F101 is provided for protection of the line circuitry.

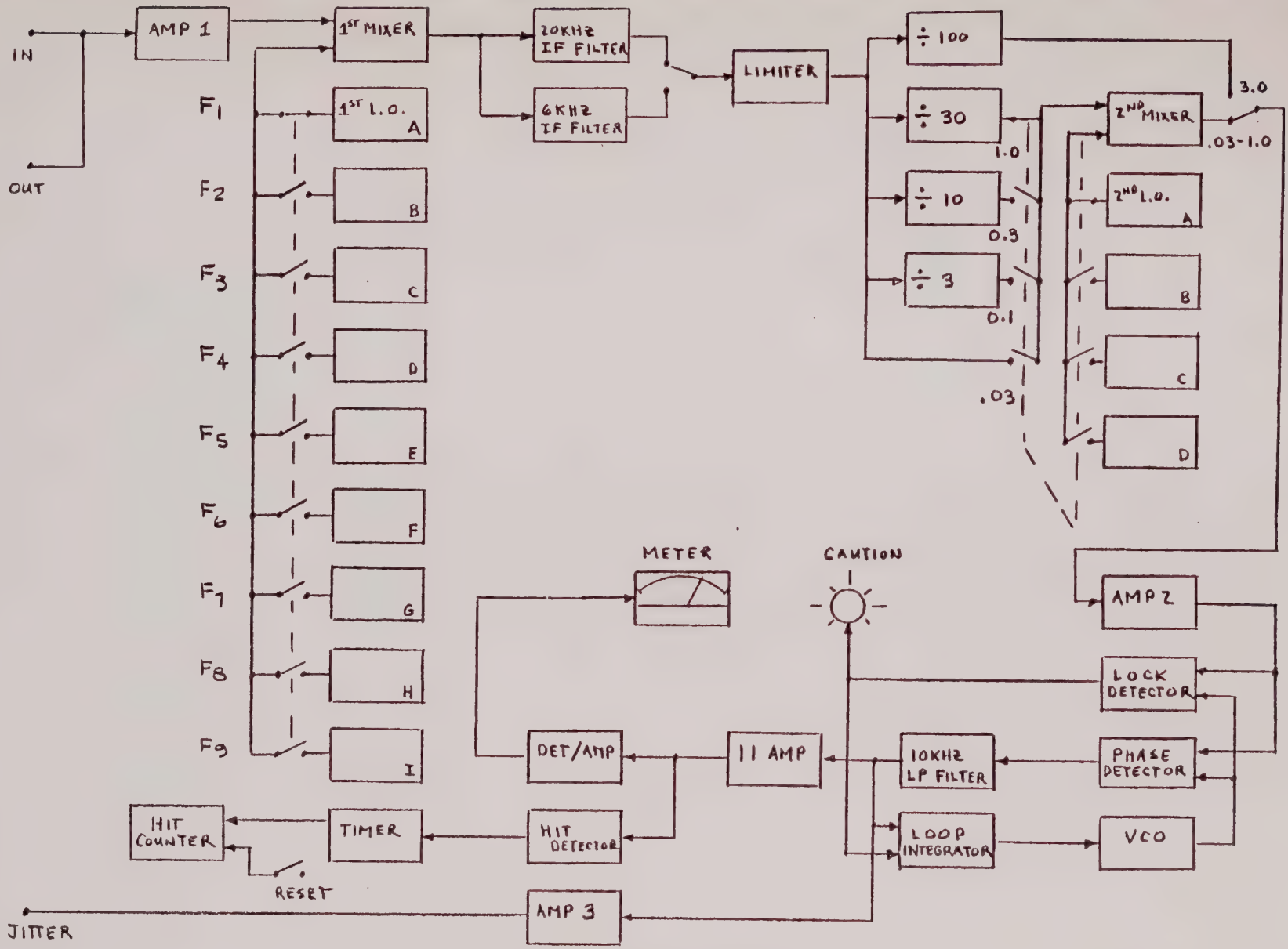
The power supply transformer has a dual primary and is suitable for 115/230 volt AC operation (optional). A center tapped secondary feeds the full wave rectifiers and filter capacitors for the dual 15 volt supply. The Zener reference voltage from D505 is amplified by transistors Q505, 508 which regulate the series pass transistor Q501. Current limiting is provided by Q504 and is set for 200 milliamps. Output voltage is controlled by R516. Additional filtering is provided by C507 and reverse voltage protection is provided by diode D503.

A similar arrangement is used in the +15 volt regulated supply. This regulator obtains its reference voltage from the -15 volt supply to provide tracking outputs.

The second winding of the power transformer provides the low voltage AC input to the unregulated, unfiltered 28 volt supply. The transformer output is rectified by D502 and transient suppression is provided by C503. No additional filtering is required.

4.2.22 220VAC/110VAC LINE OPTION

S102 provides for 220 or 110 VAC operation by switching the supply transformer primary windings from series to parallel.



MODEL 74A BLOCK DIAGRAM

FIGURE 4-1

SECTION 5.0

MAINTENANCE AND CALIBRATION

5.1 MAINTENANCE PHILOSOPHY

Maintenance procedures for the Model 74A are divided into preventive and corrective classifications. Preventive maintenance consists of the routine performance checks which may be made using the front panel controls of the instrument. Corrective maintenance covers the symptom analysis, trouble shooting, repair and recalibration of the instrument.

5.2 PREVENTIVE MAINTENANCE

5.2.1 GENERAL

The preventive maintenance procedures described in the following sections are used by the operator and the maintenance personnel to verify proper instrument operation using the front panel controls. If proper operation is not achieved, see Section 5.3 for corrective maintenance procedures.

Periodic cleaning, lubrication or inspection of the Model 74A is not required.

5.2.2 ACQUISITION CHECK

Remove the input and allow the meter reading to stabalize then replace the input and note that the meter reads above full scale, followed by the caution lamp blinking on once, followed by the meter settling (after about 10 seconds) to a low (down scale) reading.

5.2.3 RATE SELECTOR CHECK

Set the RANGE to .03, rate to the input frequency being checked. Connect a frequency synthesizer or a signal generator to the input (sinewave or squarewave source can be used). Adjust the input level for 3Vp-p. Perform the acquisition check using each of the input bit rates.

5.2.4 RANGE SELECTOR CHECK

Set the RANGE to .03, rate to F_1. Apply a sine wave or square wave signal at the F_1 rate with an amplitude of 3 v p-p to the input. Perform the acquisition check. Set the RANGE to 0.1 and perform the acquisition check. Perform the acquisition check in the 0.3, 1.0, and 3.0 RANGE positions.

5.2.5 HIT COUNTER/JITTER OUTPUT CHECK

Set the RANGE to 3.0, rate to a convenient input frequency. Connect an FM generator with center frequency equal to the selected Model 74A input frequency and 3 v p-p sine wave or square wave amplitude to the input. Sine wave modulate (FM) the input at 200 Hz rate adjusting the deviation for a 3.0 meter reading on the 3.0 RANGE. Set the TIMER to HOLD and the THRESHOLD to X7. Set the RANGE to 1.0, allow 10 seconds for the phase locked loop to reacquire, then reset the counter. Slowly rotate the THRESHOLD control toward the X3 position and note that hits began to accumulate for threshold settings of X3 and below. Set the TIMER to zero (off), set the THRESHOLD to X2, reset the counter and note that hits do not accumulate. Connect a scope to the JITTER OUTPUT and note that the output is a 200 Hz, 2 v p-p sine wave.

5.2.6 CAUTION INDICATOR CHECK

Set the RANGE to .03, rate to a convenient input frequency. Connect a 3 v p-p signal source to the input with a frequency 4 kHz higher or lower than the Model 74 input frequency selected and note that the CAUTION lamp blinks.

5.3 CORRECTIVE MAINTENANCE

5.3.1 TROUBLE SHOOTING

This section covers symptom analysis, circuit level trouble shooting, and calibration procedures for the Model 74A.

No specialized mechanical assembly or disassembly procedures are required. Accepted practices should be followed when repair is undertaken on main frame components or the printed circuit boards. Recommended trouble shooting techniques are based on signal tracing methods where a known input signal is used and the level and waveforms are verified as the signal progresses through the circuitry. Typical test equipment required to perform the trouble shooting procedures are listed in Table 5-1.

5.3.2 SYMPTOM ANALYSIS

The preventive maintenance checks of Section 5.2 are used to isolate the area in which malfunction occurs. Table 5.2 summarizes possible fault locations for each of the preventive maintenance tests.

TABLE 5-1
MAINTENANCE TEST EQUIPMENT

Description	Typical Model Number
Synthesizer	HP3330A
FM Generator	IEC F33
Counter	Monsanto 100A
Oscilloscope	Tektronix 545A
Multitester	Simpson 260

5.3.3 CIRCUIT LEVEL TROUBLE SHOOTING

The following sections describe the general procedures to be used in locating malfunctions. Where appropriate, performance standards, voltage levels, or waveform descriptions are provided to assist in the trouble shooting procedures. When a circuit has the proper input signal but the correct output cannot be measured, the components associated with that circuit should be checked and replaced if defective.

Before detailed trouble shooting is undertaken, the ±15, and +5 volt power supply voltages should be checked. Low supply voltages may result from a malfunctioning power supply or excessive current being drawn by a defective circuit. A defective integrated circuit may often be located by feeling the case temperature. Normally, the integrated circuits are moderately warm to the touch. However, when defective, they can become extremely warm, causing a painful sensation when touched.

TABLE 5-2

SYMPTOM ANALYSIS

Preventive Maintenance Check	Probable Trouble Locations
1. No response from any test	a. AC power cord b. Fuse c. Internal AC wiring on switch S101 d. Power supplies
2. Rate Selector	a. S106, +15V control for desired local oscillator (-15V for all others) b. Q301 to Q309 and Q312,Z301
3. Range Selector	a. .03 RANGE - Q319, 322, 333, Q323 b. 0.1 RANGE - Q318, Q325, Q321 Z305 c. 0.3 RANGE - Q317, Q320, Z303 d. 1.0 RANGE - Q316, Q326, Q321 Z303, Z305 e. 3.0 RANGE - Q324, Z303, Z304
4. Hit Counter/Jitter Output	a. Z407, Q405, Q406, Q422, Q423 b. Timer c. RDC-4000 Counter 7490's or 7408's d. DD-700's or SP-756's Note: d for displays only. e. Jitter output Z410
5. Caution Indicator	a. Z401, Z402, Q424 b. Q418, DS101 c. +28V supply

5.3.3.1 FIRST MIXER/LIMITER

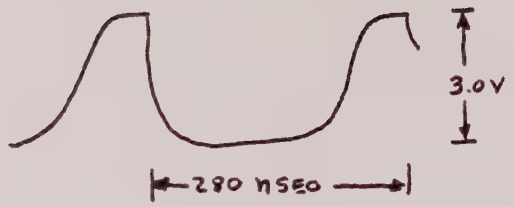
Apply a 3 v p-p sine wave or square wave input signal at one of the Model 74A input frequencies of 19.2 kHz or higher. Using an oscilloscope, check the input amplifier Q310 and Q311 by noting a 1 v p-p minimum level at Z301-12. Check the first local oscillators by selecting each of the nine input rates and noting that .6 v p-p sine waves appear at TP-2. With the rate control set to the input frequency, note that a distinct 1.2 v p-p, 10.7 MHz waveform appears at Z302-10. Change the input frequency to a specified value below 19.2 kHz, select the appropriate KILOBITS position and note that a distinct 1.2 v p-p, 10.7 MHz waveform appears at Z302-10.

5.3.3.2 RANGE DIVIDERS

Apply a 3 v p-p sine wave or square wave at one of the specified input frequencies to the input. Set the rate control to the input frequency and note a distinct 1.2 v p-p, 10.7 MHz waveform at Z302-10. Connect the scope to TP-4 (on PCB-300) and check that the waveforms shown in Figures 5-1 to 5-4 are present for the various range control settings. Check that the waveform shown in Figure 5-5 is present at TP-3 (PCB-300).

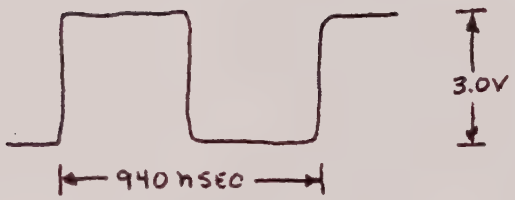
PCB-300, TP-4, .03 RANGE WAVEFORM

FIGURE 5-1



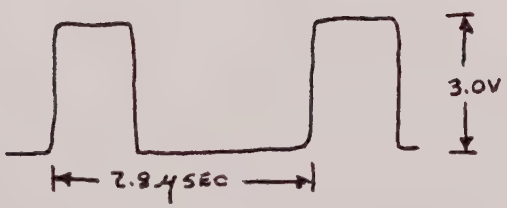
PCB-300, TP-4, 0.1 RANGE WAVEFORM

FIGURE 5-2



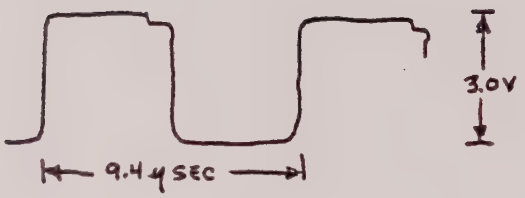
PCB-300, TP-4, 0.3 RANGE WAVEFORM

FIGURE 5-3



PCB-300, TP-4, 1.0 RANGE WAVEFORM

FIGURE 5-4



PCB-300, TP-3 WAVEFORM

FIGURE 5-5

5.3.3.3 SECOND MIXER/OUTPUT AMPLIFIER

Having observed the waveforms of Figures 5-1 to 5-5, connect the scope to TP-5 to check the second local oscillators. The amplitudes should be .6 v p-p and the frequencies as tabulated below:

RANGE	SECOND L.O. FREQUENCY	REFERENCE
.03	10.807 MHz	Q319
0.1	3.6736 MHz	Q318
0.3	1.177 MHz	Q317
1.0	463.66 kHz	Q316
3.0	Not Used	

The mixer (Z306) and output stage (Q334) are checked by noting that a 5 v p-p, 107 kHz, approximate square wave is present at Q401 collector for all five range positions.

5.3.3.4 VCO/PHASE DETECTOR

The VCO can be checked by using a scope to observe a 1.2 v p-p, 107 kHz square wave at TP-8 (PCB-400). To check tracking range, move the scope to TP-1 (PCB-400), set the RANGE to .03, and observe that a 107 kHz square wave is present for input frequencies of ±2 kHz from the selected center frequency.

5.3.3.5 LOCK DETECTOR

When the VCO is "locked" to the input signal, the level at Z402-7 should be about -14 VDC. With input signal present (107 kHz square wave at Q401 collector), but the VCO out of lock, C449 becomes charged sufficiently to cause Z402-7 to go to +14 VDC lighting the CAUTION lamp. Set the RANGE to .03, and acquire a convenient specified input frequency. With an on-scale residual phase jitter reading, a 107 kHz square wave should be present at TP-1 (PCB-400) and the CAUTION should remain off. Increase the input frequency by 4.0 kHz and note that Z402-7 toggles causing the CAUTION lamp to blink about once per second.

5.3.3.6 10 kHz LOOP FILTER

The loop filter Z402 (1, 2, 3) rejects the frequencies above 10 kHz and provides a 2.5 VDC offset so that zero phase error corresponds to zero volts DC at TP-2 (PCB-400). The frequency response can be checked by driving the R421/C445 junction with a 10 k Ω sine wave source. Using a 100 Hz, 4 v p-p input, the output at TP-2 (PCB-400) should be 3.6 v p-p, and with 10 kHz input, the output should be about 2.6 v p-p.

5.3.3.7 LOOP INTEGRATOR

The integrator provides the control voltage for the VCO. The high DC gain that it provides, tends to drive the static phase error to zero, to maintain zero volts DC at TP-2 (PCB-400). Set the RANGE to .03, and apply an input signal at a convenient specified frequency with an amplitude of 3 v p-p. Observe that a 50% duty cycle 107 kHz square wave is maintained at TP-1 (PCB-400) as the input frequency is changed ±2 kHz from the center frequency.

5.3.3.8 ABSOLUTE VALUE CIRCUIT

The absolute value circuit (Z406) gets its input at TP-2 (PCB-400) and provides output at Z406-7. For a 3.6 v p-p sine wave at TP-2 (See 5.3.3.6), the output at TP-3 is a positive full wave rectified signal with 7.2 volt peaks.

5.3.3.9 METERING DETECTOR/AMPLIFIER

The metering detector [Z407 (1, 2, and 3) and Z408 (1, 2, and 3)] averages the output of the absolute value circuit. Using the technique of 5.3.3.6, adjust the input level for .5 v p-p at TP-2 (PCB-400). Check that the level at Z408-1 goes to -12 v and that the meter reads approximately full scale.

5.3.3.10 HIT DETECTOR

The hit detector circuits consist of Z407 (5, 6, and 7) and Q405 and Q406. Drive the loop filter as mentioned in 5.3.3.6 and adjust the threshold to X2. Use the scope to observe that waveform at 400J has 3 v p-p minimum level. Set the timer to HOLD and reset the hit counter. Observe that the count accumulates up to 9999 and then stops.

5.3.3.11 OUTPUT AMPLIFIER

The output amplifier is checked by driving the loop filter as mentioned in Section 5.3.3.6 to get 3.6 v p-p at TP-2 (PCB-400). This level should provide 6.5 v p-p at the JITTER OUTPUT across 600 Ω load.

5.3.4 CALIBRATION

The following procedures are used to recalibrate the various sections of the Model 74A. Recalibration is normally required when maintenance has been performed on the associated circuitry or when there is reason to suspect that the calibration is no longer accurate.

5.3.4.1 FIRST LOCAL OSCILLATORS

Before adjusting the oscillators, allow 30 minutes warm up with the top and bottom covers so that the oscillators will be brought on frequency at approximately the normal operating temperature. Remove the top cover, connect the counter to TP-2 (PCB-300) and adjust each oscillator to within 10 Hz of the frequencies specified in Table 1-2.

RATE SELECTED	ADJUSTMENT
F_1	C313
F_2	C317
F_3	C321
F_4	C325
F_5	C329
F_6	C333
F_7	C337
F_8	C341
F_9	C345

5.3.4.2 SECOND LOCAL OSCILLATORS

Before adjusting the oscillators, allow 30 minutes warm up with the top and bottom covers on, so that the oscillators will be brought on frequency at approximately the normal operating temperature. Remove the top cover, connect the counter to TP-5 (PCB-300) and adjust each oscillator to within 10 Hz of the frequencies tabulated below.

Range Selected	Frequency (at TP-5)	Adjustment
.03 BITS	10.807000 MHz	C366
0.1 "	3.673660 "	C362
0.3 "	1.177000 "	C358
1.0 "	463.666 kHz	C354
3.0 "	Not Used	

5.3.4.3 PHASE DETECTOR OFFSET

Apply a 3 v p-p square wave at a convenient specified frequency to the input and set the range switch to 3.0. Connect a scope to TP-1 (PCB-400) and adjust R429 for a 50% duty cycle at TP-1.

5.3.4.4 VCO ADJUSTMENT

This is a factory adjustment and should not require readjustment. To verify proper operation, vary the input frequency ±2 kHz from the selected center frequency while monitoring the voltage at TP-4 on the PCB-400. The voltage at TP-4 should be within ±10 VDC over the frequency range. If necessary, adjust L403.

5.3.4.5 HIT AND JITTER OFFSETS

Ground TP-2 (PCB-400), adjust R4125 for 0 VDC at 400S, and adjust R4132 for as close as possible to 0 VDC at TP-3 (PCB-400).

5.3.4.6 JITTER METER CALIBRATION

Set the RANGE to 3.0, and select a convenient specified input rate. Connect an FM generator to the input and set the carrier frequency equal to the selected input rate. Sine wave modulate the carrier at a 200 Hz rate adjusting the modulation input level for an FM index of 26.66 (peak deviation 5.33 kHz). The generator sensitivity (deviation vs modulation input level) can be measured by using a spectrum analyzer and observing the modulation levels required for carrier nulls. Nulls occur when the FM index is 2.40, 5.52, 8.65, etc. The level for 26.66 index is then 3.08 times the level for 8.65 index. When the 26.66 index has been set up, adjust R494 for a reading of 3.0. Attenuate the modulation input 10 dB (index changed to 8.43) and adjust R493 for a meter reading of .95 (on the 3.0 RANGE). Remove the 10 dB attenuator and check that the meter reading is 3.0. Since there is some interaction, the adjustments may have to be repeated a few times until the 3.0 and .95 points fall in.

TABLE 5-3 74A MAIN FRAME PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-6	DS101, 102	Lamp	327	GE
	F101	Fuse, 1 amp. Slo-Blo	3AG	Littlefuse
	M101	Meter, 0-50 Microamps	74-022A	HLI
	R101	Resistor, Fixed, 23.7K, 1%, 1/2w	RN60D	
	R102	Resistor, Variable, 50K	57M	Clarostat
	R103	Resistor, Fixed, 63.4K, 1%, 1/2w	RN60D	
	R104	Resistor, Fixed, 270Ω, 1/4w, 5%	RC07	A-B
	S101	Switch, Push, 1 pole, 2 position	616-12-1	Marco Oak
	S102	Not Used		
	S103	Switch, Push, 1 pole, 2 position	30-1	Grayhill
	S104	Not Used		
	S105	Switch, Push, 5 pole, 2 position	7K05-322N-S000	UID
	S106	Switch, Push, 9 pole, 2 position	7K09-322N-S000	UID
	S107	Not Used		
	T101	Not Used		
		Timer	90024	Rhodes
		Hit Counter	RDC-4000	Keltron

TABLE 5-3 74A MAIN FRAME PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-6		+5V/+200V Supply	PS2G	Keltron

TABLE 5-5 HLI 74A-300 BOARD PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-10	C301	Capacitor, Tantalum, 2.2 mfd, 15V	150D	Sprague
	C302	Same as C301		
	C303	Capacitor, Ceramic Disc, .1 mfd, 10V	UK	Centralab
	C304	Same as C301		
	C305	"		
	C306 thru C311	Same as C303		
	C312	Capacitor, Ceramic Disc, .1 mfd, 20V	UK	Centralab
	C313	Capacitor, Variable, 5-5-18 pf	538	Erie
	C314	Same as C322		
	C315	" C319		
	C316	" C312		
	C317	" C313		
	C318	" C322		
	C319	Capacitor, Dipped Mica, 22 pf, 500V	DM15	Arco
	C320	Same as C312		
	C321	Same as C313		
	C322	Capacitor, Dipped Mica, 30 pf, 500V	DM15	Arco

TABLE 5-5 HLI 74A-300 BOARD PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-10	C323	Same as C319		
	C324	" C312		
	C325	" C313		
	C326	" C322		
	C327	" C319		
	C328	" C312		
	C329	" C313		
	C330	" C322		
	C331	" C319		
	C332	" C312		
	C333	" C313		
	C334	" C322		
	C335	" C319		
	C336	" C312		
	C337	" C313		
	C338	" C322		
	C339	" C319		
	C340	" C312		
	C341	" C313		

TABLE 5-5 HLI 74A-300 BOARD PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-10	C342	Same as C322		
	C343	" C319		
	C344	" C312		
	C345	" C313		
	C346	" C322		
	C347	" C319		
	C348	" C303		
	C349	" "		
	C350	" "		
	C351	" "		
	C352	" "		
	C353	" C312		
	C354	" C313		
	C355	" C322		
	C356	" C319		
	C357	" C312		
	C358	" C313		
	C359	" C322		

TABLE 5-5 HLI 74A-300 BOARD PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-10	C360	Same as C319		
	C361	" C312		
	C362	" C313		
	C363	" C322		
	C364	" C319		
	C365	" C312		
	C366	" C313		
	C367	" C322		
	C368	" C319		
	C369, C370	" C303		
	C371	Capacitor, 22 mfd, 15V	CS13B	Sprague
	C372 thru C380	Same as C303		
	C381	Capacitor, Ceramic Disc, .001 mfd	5GAD10	Sprague
	C382	Capacitor, Mylar, .0022 mfd, 100V	MWR	Standard
	C383 thru C385	Same as C303		
	C386, 387	Same as C371		

TABLE 5-5

HLI 74A-300 BOARD PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-10	C388 thru C393	Capacitor, Ceramic Disc, .01 mfd	UK	Centralab
	D301 thru D376	Diode, Silicon	IN3064	Motorola
	L301	Inductor, 1 mh, ±10%	WEE-1000	Nytronics
	Q301 thru Q309	Transistors, Silicon	2N5639	Motorola
	Q310 thru Q313	" "	2N3563	"
	Q314 thru Q326	Transistor, Silicon	2N5639	Motorola
	Q327	Transistor, Silicon	2N3440	RCA
	Q328 thru Q330	Transistor, Silicon	2N5138	Fairchild
	Q331 thru Q333	Transistor, Silicon	2N3563	Motorola
	Q334	Transistor, Silicon	2N3566	Fairchild
	Q335 thru Q336	Transistor, Silicon	2N5639	Fairchild

TABLE 5-5

HLI 74A-300 BOARD PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
	R302	Resistor, Fixed, 10 K, 5%, 1/4w comp.		
5-10	R303	Resistor, Fixed, 10K, 5%, 1/4w comp		
	R304	" " , 1K, " "		
	R305	" " , 300Ω, " "		
	R306, 307	" " , 1K, " "		
	R308	Not Used		
	R309	Not Used		
	R310	Resistor, Fixed, 3.9K, 5%, 1/4w comp.		
	R311	" " , 300Ω, " "		
	R312, 313	" " , 10K, " "		
	R314	" " , 2.0K, " "		
	R315 thru R318	" " , 2K, " "		
	R319	Not Used		
	R320 thru R325	Resistor, Fixed, 2K, 5%, 1/4w comp.		
	R326	Not Used		
	R327	Resistor, Fixed, 750Ω, 5%, 1/4w comp.		
	R328	" " , 51Ω, " "		

TABLE 5-5

HLI 74A-300 BOARD PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-10	R329	Resistor, Fixed, 300Ω, 5%, 1/4w, comp.		
	R330	" " , 51Ω, " "		
	R331	" " , 300, " "		
	R332	" " , 1K, " "		
	R333	" " , 1.5K, " "		
	R334	" " , 1 MEG, " "		
	R335	" " , 51Ω, " "		
	R336	" " , 1 MEG, " "		
	R337	" " , 510Ω, " "		
	R338	Resistor, Fixed, 3.9K, 5%, 1/4w, comp.		
	R339 thru R342	" " , 2K, " "		
	R343	" " , 300Ω, " "		
	R344	" " , 1K, " "		
	R345	" " , 510Ω, " "		
	R346	" " , 510Ω, " "		
	R347	" " , 1 MEG," "		
	R348	" " , 1 MEG," "		

TABLE 5-5 HLI 74A-300 BOARD PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-10	R349	Resistor, Fixed, 100K, 5%, 1/4w, comp.		
	R350	" " , 1 MEG, " "		
	R351	Not Used		
	R352	Not Used		
	R353	Not Used		
	R354	Resistor Fixed, 100K, 5%, 1/4w, comp.		
	R355	" " , 1M, " "		
	R356	" " , 1 MEG," "		
	R357	" " , 100K, " "		
	R358	" " , 82Ω, 1w, 5%, comp.		
	R359	" " , 1K, 5%, 1/4w, comp.		
	R360	" " , 10K, " " "		
	R361	" " , 5.1K," "		
	R362	Not Used		
	R363	Not Used		
	R364	Resistor, Fixed, 1 MEG, 5%, 1/4w, comp.		
	R365	" " , 100K, " "		
	R366	" " , 100K, " "		

TABLE 5-5 HLI 74A-300 BOARD PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-10	R367	Resistor, Fixed, 1 MEG, 5%, 1/4w, comp.		
	R368	" " , 1K, " "		
	R369	" " , 2K, " "		
	R370	" " , 3.9K, " "		
	R371	" " , 300 , " "		
	R372	" " , 10K, " "		
	R373	" " , 2K, " "		
	R374	" " , 10K, 5%, 1/4w, comp.		
	R375	" " , 100K, " "		
	R376	" " , 20K, " "		
	R377	" " , 10K, " "		
	R378	" " , 1K, " "		
	R379	" " , 200, " "		
	R380	" " , 1K, " "		
	R381	Not Used		
	R382	Not Used		
	R383	Resistor, Fixed, 1K, 5%, 1/4w, comp.		
	R384	" " , 1K, " "		

TABLE 5-5 HLI 74A-300 BOARD PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-10	R385 thru R389	Resistor, Fixed, 100K, 5%, 1/4w, comp.		
	R390	" " , 10K, " "		
	R391	" " , 10K, " "		
	R392	" " , 1 MEG, 5%, 1/4w, comp.		
	R393	" " , 1 MEG, " "		
	R399	" " , 10K, " "		
	X301 thru X309	Crystals (selected frequencies)		Jan
	X310	Crystal, .46366 MHz		Jan
	X311	" , 1.1770 MHz		Jan
	X312	" , 3.6736 MHz		"
	X313	" , 10.807 MHz		
	Y301	Filter, 6 kHz bandpass	A0230	Heath Dynamics
	Y302	Filter, 20 kHz bandpass	A0180	"
	Z301	Integrated Circuit	MC1357	Motorola
	Z302	" "	"	"
	Z303	" "	74196	"
	Z304	" "	74196	"
	Z305	" "	7474	"

TABLE 5-5 HLI 74A-300 BOARD PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-10	Z306	Integrated Circuit	MC1357	Motorola

TABLE 5-6 HLI 74A-400 BOARD PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-12	C401	Capacitor, Paper, 22 mfd, 15V	CS13BD	Sprague
	C402	Capacitor, Ceramic Disc, .1 mfd, 10V	UK	Centralab
	C403	Not Used		
	C404	Capacitor, Dipped Mica, 62 pf, 500V	DM15	Arco
	C405	Capacitor, Ceramic Disc, .1 mfd, 20V	UK	Centralab
	C406	Same as C402		
	C407	Capacitor, Ceramic Disc, .001 mfd, 1KV	5GAD10	Sprague
	C408	Same as C404		
	C409 thru C412	Same as C401		
	C413, 414 thru C427	Not Used		
	C428	Same as C405		
	C429	Not Used		
	C430	Capacitor, Ceramic Disc, .01 mfd, 25V	HY-520	Sprague
	C431	Capacitor, Dipped Mica, 360 pf, 500V	DM-15	Arco
	C432 thru C434	Same as C402		

TABLE 5-6 HLI 74A-400 BOARD PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-12	C435	Same as C402		
	C436	Capacitor, Tantalum, 22 mfd, 15V	CS13B	Sprague
	C437	Not Used		
	C438	Capacitor, Fixed, .01 mf, Disc		
	C439	Not Used		
	C440	Same as C401		
	C441	Capacitor, Manolithic, 2.2 mfd, 50V	Z5U	Sprague
	C442	Same as C441		
	C443	Capacitor, Polystyrene, .027 mfd, 33V		Mial
	C444	Capacitor, Elect., 150 mfd, 16V	30D	Sprague
	C445	Capacitor, Polystyrene, 1600 pf, 33V		Mial
	C446	Capacitor, Dipped Mica, 470 pf, 500V	DM15	Arco
	C447	Capacitor, Dipped Mica, 51 pf, 500V	DM15	Arco
	C448	Not Used		
	C449	Same as C401		
	C450	Capacitor, Tantalum, 2.2 mfd, 15V	150D	Sprague
	C451	Same as C430		
	C452	Capacitor, Disc, .022 µf, 50V	UK-50	Centralab
	D401	Diode, Silicon	IN706A	Motorola
	D402	Diode, Silicon	IN3064	Motorola

TABLE 5-6 HLI 74A-400 BOARD PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-12	D403, 404	Diode, Silicon	IN3064	Motorola
	D405 thru D407	Not Used		
	D408	Diode, Variable, Capacitence	MV1404	Motorola
	D409, 410	Not Used		
	D411 thru D414	Diode, Silicon	IN3064	Motorola
	D415	Not Used		
	D416 thru D420	Diode, Silicon	IN3064	Motorola
	D421 thru D424	Not Used		
	D425	Not Used		
	D426 thru D434	Same as D411		
	D4108	Same as D411		
	L401, 402	Not Used		
	L403	Inductor, Variable, 4.3 mh	74-L403	HLI
	Q401 thru Q404	Transistor, Silicon	2N2369	Motorola
	Q405, 406	Transistor, Silicon	2N3566	Fairchild
	Q407 thru Q410	Not Used		

TABLE 5-6 HLI 74A-400 BOARD PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-12	Q411, 412	Transistor, Silicon	2N5639	Motorola
	Q413 thru 416	Not Used		
	Q417	Same as Q411		
	Q418	Transistor, Silicon	2N3440	RCA
	Q419, 420	Not Used		
	Q421	Transistor, Silicon	2N6523	Motorola
	Q422	" "	2N2369	"
	Q423	Not Used		
	Q424	Transistor, Silicon	2N2369	"
	R401	Resistor, Fixed, 10Ω , 5%, 1/4w		
	R402	" " , 510Ω, " "		
	R403	" " , 1K, " "		
	R404	" " , 3.3K, " "		
	R405	" " , 15K, " "		
	R406	" " , 3.3K, " "		
	R407	" " , 270Ω, " "		
	R408	Not Used		
	R409	Resistor, Fixed, 3.3K, 5%, 1/4w		
	R410	" " , 15K, " "		

TABLE 5-6 HLI 74A-400 BOARD PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-12	R411	Resistor, Fixed, 3.3K, 5%, 1/4w		
	R412	" " , 270Ω, " "		
	R413	" " , 1K, " "		
	R414	" " , 1K, " "		
	R415	" " , 10K, " "		
	R416	Not Used		
	R417	Resistor, Fixed, 51K, 5%, 1/4w		
	R418	" " , 620K, " "		
	R419	" " , 3.6 MEG, 5%, 1/4w		
	R420	Not Used		
	R421	Resistor, Fixed, 10K, 5%, 1/4w		
	R422	" " , 100K, 1%, 1/4w	RN60D	
	R423	" " , 100K, 5%, 1/4w		
	R424	" " , 100K, 1%, 1/4w	RN60D	
	R425	" " , 150K, 5%, 1/4w		
	R426	" " , 240K, " "		
	R427	" " , 24K, " "		
	R428	" " , 2.4K, " "		

TABLE 5-6 HLI 74A-400 BOARD PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-12	R429	Resistor, Variable, 50K, 1/2w	72PMR50K	Helipot
	R430	" " , 10Ω, 5%, 1/4w		
	R431	" " , 10Ω, " "		
	R432	" " , 10Ω, " "		
	R433	" " , 10Ω, " "		
	R434	Not Used		
	R435 thru R457	Not Used		
	R458	Resistor, Fixed, 100K, 5%, 1/4w		
	R459	" " , 3.9K, " "		
	R460	" " , 300Ω, " "		
	R461	" " , 1 MEG, " "		
	R462	Not Used		
	R463	Resistor, Fixed, 100K, 5%, 1/4w		
	R464	" " , 30K, " "		
	R465	" " , 62K, " "		
	R466	Not Used		
	R467	Not Used		

TABLE 5-6 HLI 74A-400 BOARD PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-12	R468	Resistor, Fixed, 15K, Factory Select		
	R469 thru R472	" " , 60.4K, 1%, 1/4w	RN60D	
	R473	" " , 9.09K, " "	"	
	R474	" " , 10.0K, " "	"	
	R475	" " , 24K, 5%, 1/4w		
	R476	" " , 270Ω, " "		
	R477	" " , 3.3K, " "		
	R478	" " , 300 , " "		
	R479	" " , 24K, " "		
	R480	" " , 3.3K, " "		
	R481, 482	Not Used		
	R483	Resistor, Fixed, 10K, 5%, 1/4w		
	R484	" " , 100K, " "		
	R485	" " , 16K, " "		
	R486	" " , 100K, " "		
	R487	" " , 100K, " "		
	R488	" " , 97.6K, 1%, 1/4w	RN60D	

TABLE 5-6 HLI 74A-400 BOARD PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-12	R489	Resistor, Fixed, 1.6 MEG, 5%, 1/4w		
	R490	" " , 5.6K, " "		
	R491	" " , 100K, " "		
	R492	" " , 270Ω, " "		
	R493	Resistor, Variable, 50K, " "	72PMR50K	Helipot
	R494	" " , 50K, " "	"	"
	R495	" " , 182K, 1%, "	RN60D	
	R496	" " , 10Ω, 5%, 1/4w		
	R497	" " , 10K, " "		
	R498	" " , 100K, " "		
	R499	" " , 510Ω, " "		
	R4100	" " , 100K, " "		
	R4101	" " , 511K, " "		
	R4102 thru R4107	Not Used		
	R4108	Resistor, Fixed, 100K, 5%, 1/4w		
	R4109	" " , 51K, " "		
	R4110	" " , 10K, " "		

TABLE 5-6 HLI 74A-400 BOARD PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-12	R4111 thru R4113	Not Used		
	R4114	Resistor, Fixed, 10K, 5%, 1/4w		
	R4115	Resistor, Fixed, 270K, 5%, 1/4w		
	R4116	Not Used		
	R4117	Resistor, Fixed, 10Ω, 5%, 1/4w		
	R4118, 4119	Not Used		
	R4120	Resistor, Fixed, 560Ω, 5%, 1/4w		
	R4121	" " , 27K, " "		
	R4122	" " , 100K, " "		
	R4123	" " , 100Ω, " "		
	R4124	" " , 100K, " "		
	R4125	Resistor, Variable, 50K, 5%, 1/4w	72PMR50K	Helipot
	R4126	" " , 20K, " "		
	R4127	" " , 100K," "		
	R4128	" " , 100K," "		
	R4129	Not Used		
	R4130	Resistor, Variable, 100Ω, 5%, 1/4w		

TABLE 5-6 HLI 74A-400 BOARD PARTS LIST

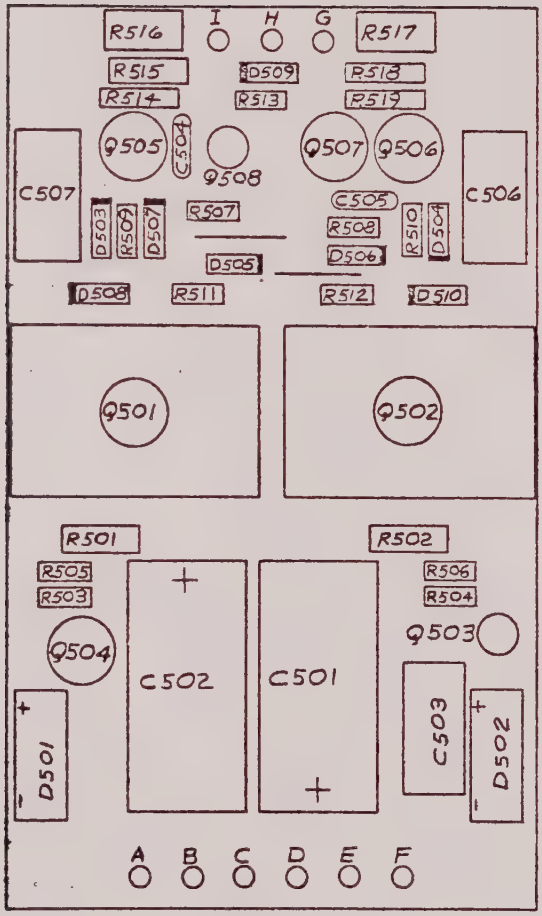
Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-12	R4131	Resistor, Fixed, 100K, 5%, 1/4w		
	R4132	Resistor, Variable, 50K, 5%, 1/4w	72PMR50K	Helipot
	R4133 thru R4138	Not Used		
	R4140	Resistor, Fixed, 3.9K, 5%, 1/4w		
	R4141	" " , 20K, " "		
	R4142	" " ,,130K, " "		
	X401, 402	Not Used		
	Z401	Integrated Circuit	CD4001AE	RCA
	Z402	" "	N5558V	Signetics
	Z403, 404	Not Used		
	Z405	Integrated Circuit	MC1357	Motorola
	Z406 thru Z408	Same as Z402		
	Z409	Integrated Circuit	8007C	Intersil
	Z410	Same as Z402		

TABLE 5-7 POWER SUPPLY PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-14	C501, 502	Capacitor, Electrolytic, 330 mfd, 35 vdc	TAD	IEC
	C503	Capacitor, Paper, .22 mfd	225P	Sprague
	C504, 505	Capacitor, Ceramic, 200 pfd, 10%	Z5U	Sprague
	C506, 507	Capacitor, Electrolytic, 22 mfd, 35 vdc	TAD	IEC
	D501, D502	Full Wave Bridge Silicon Rect.	FW-100	Mallory
	D503, 504	Diode, Silicon	1N4002	Fairchild
	D505	Diode, Zener	1N751A	GE
	D506 - D510	Diode, Silicon	IN3064	Fairchild
	R501, 502	Resistor, Fixed, 2.4 ohm, 5%, 1/2w		
	R503, 504	Resistor, Fixed, 47 ohm, 5%, 1/4w		
	R505, 506	Resistor, Fixed, 1K, 5%, 1/4w		
	R507, 508	Resistor, Fixed, 1.5K, 5%, 1/4w		
	R509	Resistor, Fixed, 820 ohm, 5%, 1/4w		
	R510	Resistor, Fixed, 15K, 5%, 1/4w		
	R411	Resistor, Fixed, 22K, 5%, 1/4w		
	R412	Resistor, Fixed, 680K, 5%, 1/4w		
	R513	Same as R510		

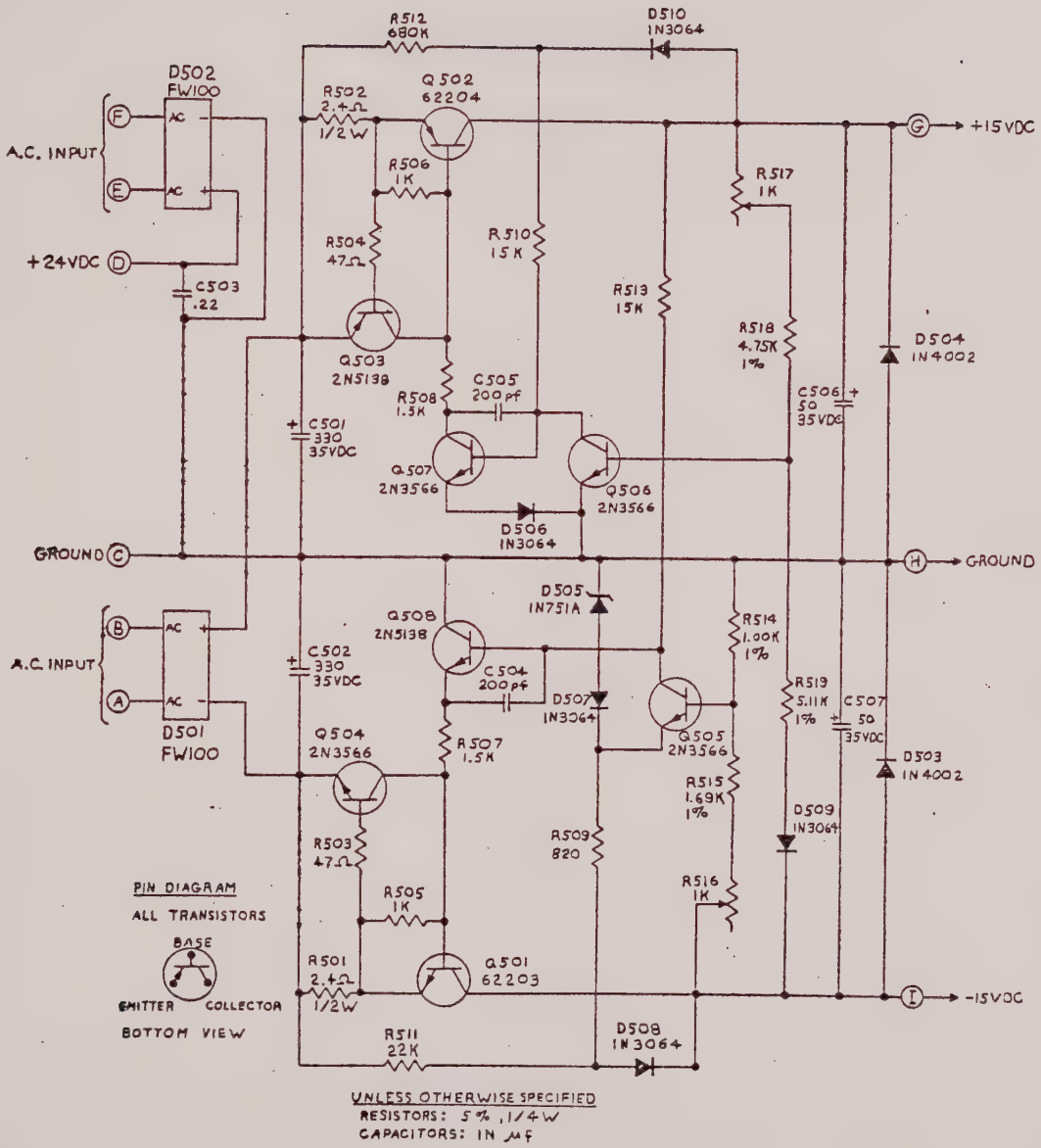
TABLE 5-7 POWER SUPPLY PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-14	R514	Resistor, Fixed 1K, 1%, 1/4w	RN60D	
	R515	Resistor, Fixed, 1.82K, 1%, 1/4w	RN60D	
	R516, 517	Resistor, Variable, 1K, 10%, 1/2w	72YWR1K	Helipot
	R518	Resistor, Fixed, 4.75K, 1%, 1/4w	RN60D	
	R519	Resistor, Fixed, 5.11K, 1%, 1/4w	RN60D	
	Q501	Transistor, Silicon	62203	RCA
	Q502	Transistor, Silicon	62204	RCA
	Q503	Transistor, Silicon	2N5138	
	Q504, 505	Transistor, Silicon	2N3566	
	Q506	Same as Q503		
	Q507	Same as Q504		



HLI 74-500 COMPONENT LAYOUT

FIGURE 5-13



HLI 74-500 SCHEMATIC DIAGRAM

FIGURE 5-14

APPENDIX

Manufacturers Data Sheets

1. Minidiget Counter/Display Module
2. Powertec 3B5 - .35 Power Supply

Instruction Manual For

MINIDIGET

DECODE / DISPLAY and
COUNTER / DISPLAY MODELS

with and without memory

NOTE: Correction pg. 5.2

November 21, 1972

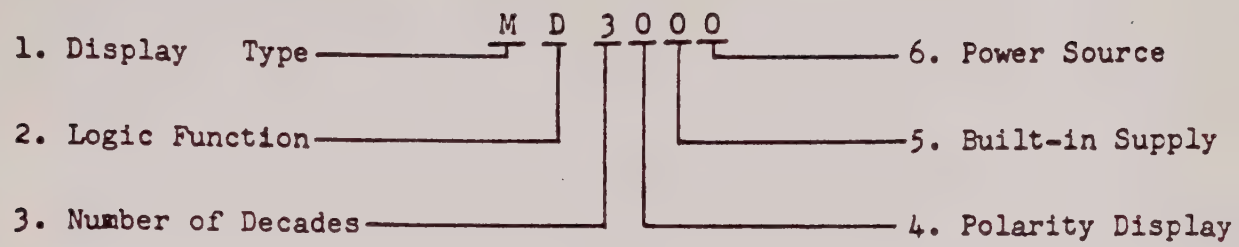
General

This manual covers the series of displays and counter-displays manufactured with or without memory capability. These are available with either Nixie tube or incandescent type seven segment tube displays with units having two (2) to nine (9) digit capacity. Denoted the MD, MDM, MDC, MDCM, SD, SDM, SDC, SDCM series, these are available with Polarity Display and / or Built-in Power Supply options.

Nomenclature and options are discussed more fully in the text that follows.

Section I ..... Model Number System
Section II ..... Electrical Specifications
Section III ..... Mechanical Specifications
Section IV ..... Installation & Mounting
Section V ..... Connecting the Unit
Section VI ..... Operating the Unit
Section VII ..... In Case Of Trouble

I. Model Number System



1. Display Type

   a. M = Nixie
   b. S = Seven Segment Incandescent
   c. L = LED
   d. P = Projection

2. Logic Function

   a. D- = Decode/Dsiplay
   b. DM = Decode/Display with memory
   c. DC = Unidirectional Counter
   d. DCM = Unidirectional Counter with memory

3. Number of Decades:

   Number in this position indicates number of <u>numerical</u> display positions.

4. Polarity Display

   0 = No polarity display
   1 = Polarity Display - Unit has mechanical configurations one decade larger than number in Item 3.

5. Built-in Supply

   0 = No internal power supply
   1 = Built-in 200 volt supply
   2 = Built-in 200 volt and 5 volt supply.

6. Power Source

   0 = External DC Power Required
   1 = Operates from 115 VAC, 55-400 Hz.
   2 = Operates from 220 VAC, 47-400 Hz.

II. Electrical Specifications

A. Power Nixie-Tube Models

1. 200 VDC unregulated at 2.5 MA per Display position, where higher voltages are found, it is recommended that a suitable dropping resistor be installed to insure maximum life of decoder driver and nixie tube.

2. Regulated 5 VDC ± 5% is required at the following current:

MD - 22 MA per decade
MDM - 53 MA per decade
MDC - 71 MA per decade
MDCM -103 MA per decade

+ 32 MA for units with polarity option.

B. Segmented Display Models

1. Regulated 5 VDC ± 5% is required at the following current:

SD - 214 MA per decade
SDM - 245 MA per decade
SDC - 263 MA per decade
SDCM - 295 MA per decade

+ 65 MA for units with polarity option.

C. Logic Functions

1. BCD input - Series MD, MDM, SD, and SDM accept positive true 4 line BCD 8,4,2,1 coded information. Load is equal to 1 TTL load.

Logic "0" 0 to .4 V @ -1.6 MA max.
Logic "1" +2.4 to 5.0 V @ +40 uA max.

2. BCD Output - Series MDC, MDCM, SDC, SDCM and some MDM models have 4 line BCD 8421 coded outputs and can drive the levels equivalent of 10 TTL loads.

Logic "0" 0 to .4 V @ -16 MA
Logic "1" + 2.4 to 5.0V @ .4 MA

3. Count Input - All unidirectional counters accept a count input signal of the following electrical specifications:

Load ...2TTL gate loads
Low "0" ... 0 to +.4 V @ -3.2 MA max.
High "1" ... +2.4 to 5.0 V @ 80 uA max.
Pulse width (high) ...100 nsec min.
Rise and fall time ...1.0 μsec max.
Count Frequency ... 5 MHz max.
Count occurs on the fall of the input

D. Memory Gate
Models with memory have individual memory gate lines on each decade which respond to the following signal.

Load ... 8 TTL gate loads per decade
Low "0" ... 0 to 0.4 V @ -12.8 MA
High "1" ... +2.4 to 5.0V @ 32 MA
Pulse width high ... 100 msec min

E. Reset
All unidirectional counters can be reset to "zeroes" by placing a logic 1 on the Reset Pin.

Load ... 1TTL gate load per decade
Low "0" ... 0 to 0.4 V @ -1.6 MA
High "1" (reset) ... +24 to 5.0 V @ 80 uA
Pulse width high ... 100 msec per decade

F. BCD Strobe
On all units with BCD output, the BCD can be disabled by placing a logic "0" on the BCD strobe pin.

Impedance ... 4 TTL gate loads per decade
Low"0" ... 0 to o.4 @ -6.4 MA
Low "1" ... +2.4 to 5.0 V @ .16 MA

G. Lamp Test
All segmented displays are equipped with a lamp test line. A logic "0" on this line, lights all segments and is a safety precaution against a burned out segment causing an incorrect display. Load is 1 TTL load per digit.

Impedance
Low "0"
High "1"

H. Decimal Points
On either nixie tube of segmented displays, a decimal point can be lighted by connecting the appropriate pin to ground.

M Models - high or off 60 V min
- low or on 0-5V at 2.5 MA

S Models - high or off 5V at no I
- low or on 0V $\pm$ .3 at 23 MA

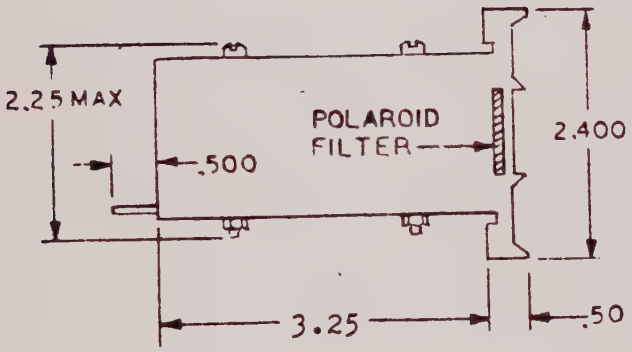
I. Polarity

Polarity input is 1 TTL gate
Polarity output is 10 TTL gates
Polarity memory is 2 TTL gates
A logic 1 at the input terminal causes a "plus" sign to be displayed.

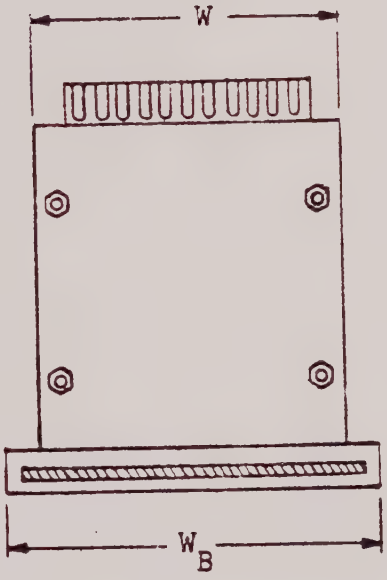
III Mechanical Specifications

A. For Units <u>without</u> built-in power

SIDE VIEW



TOP VIEW



W - is calculated as follows: .78 + N(.600) ; where N is the number of decades.

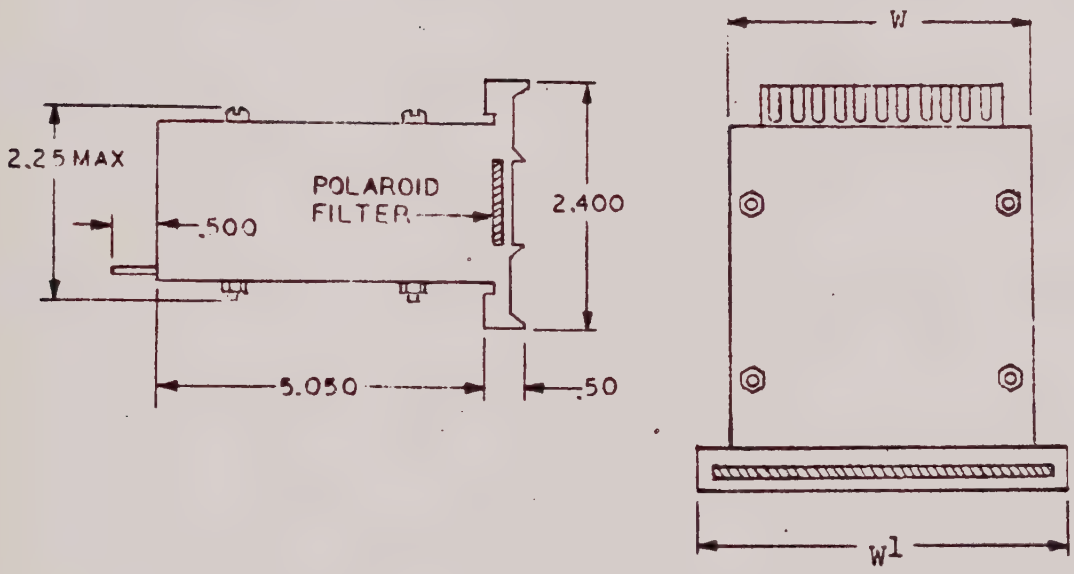
W_B is calculated as follows: 1.38 + N(.600)

Polarity option occupies space of 1 decade

B. Units with built-in power supply. Nixie tube displays and counters between 2 and 6 decades are available with built-in power supply.

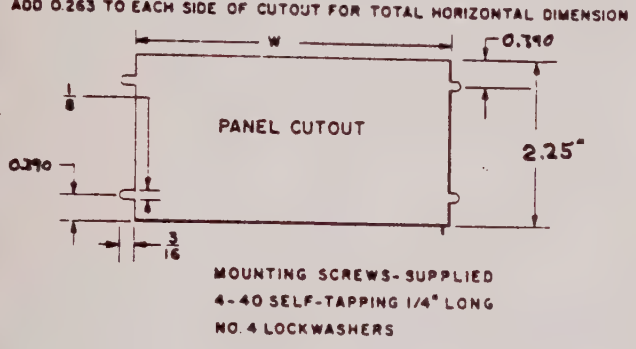
SIDE VIEW

TOP VIEW

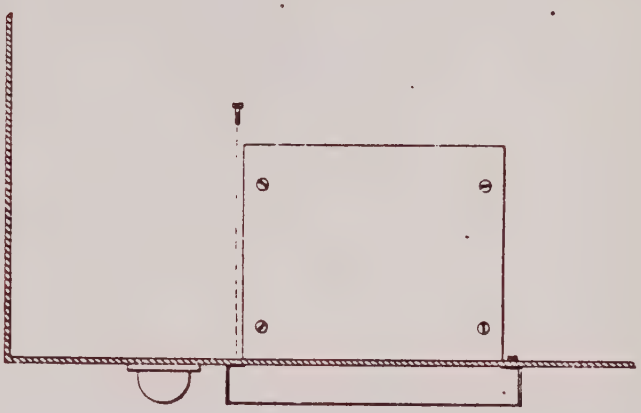


For 2,3, and 4 decade units W = 4.075; W^1 = 4.675
For 5 and 6 decade units W = 5.275; W^1 = 5.875
Polarity option is considered a decade.

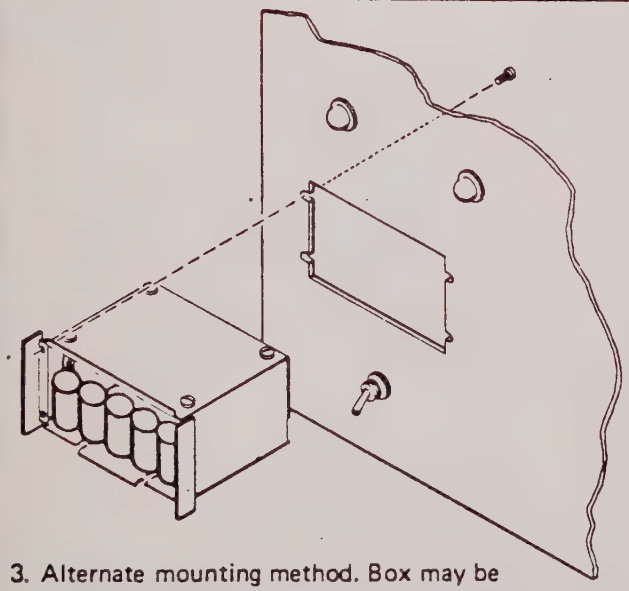
DIMENSION-W add .075" to width of unit calculated from section 3



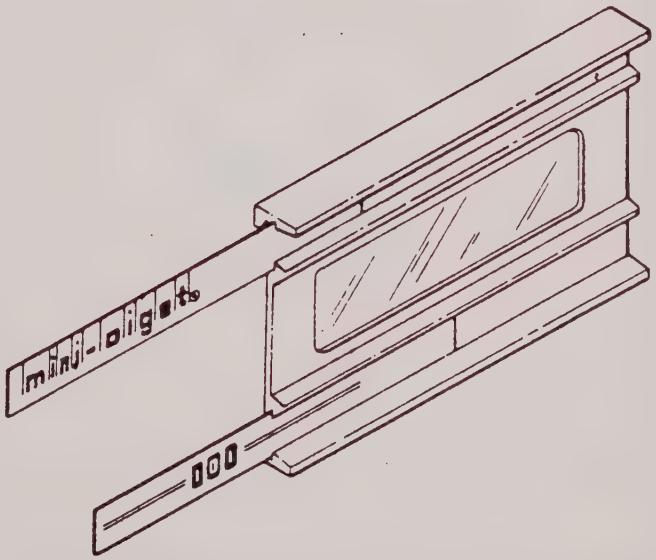
1. Panel cutout for fitment of all MINI-DIGET boxes and bezels.



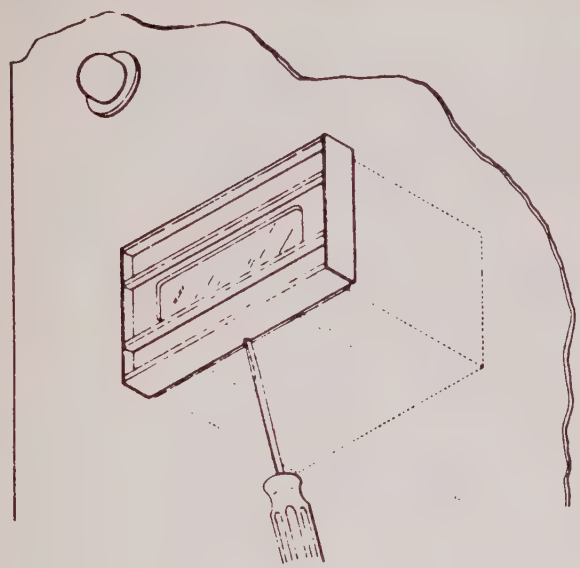
2. Top view for mounting assembled MINI-DIGET unit. Screws may be driven home from inside panel.



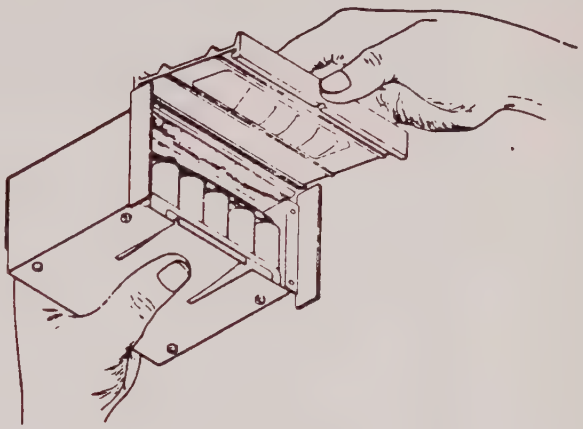
3. Alternate mounting method. Box may be mounted in panel without bezel. Self-threading screws are driven from inside panel.



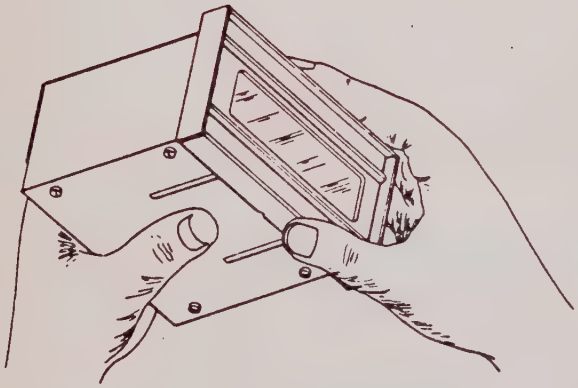
4. With bezel removed from box, labels can be added or removed.



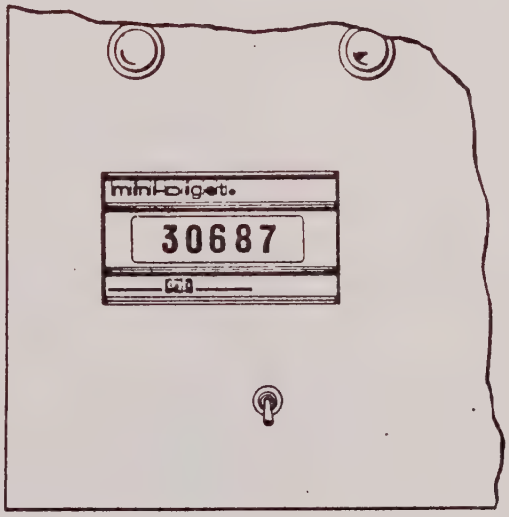
5. Method of removing or attaching bezel. Press lower tongue inward with small screwdriver, awl, or nail, and slip bezel on or off. Tongue locks bezel in place.



6. Method of attaching or detaching bezel when MINI-DIGET unit is not mounted in panel.



7. MINI-DIGET unit ready for panel installation. Tongue may be depressed or lowered for looser or tighter lock.



8. MINI-DIGET properly mounted on panel and in operation.

V. Connecting the Unit

A. Power and logic function connections to the unit are made through a P.C. card edge connector on the rear of the unit. Because of the number of types of terminations available, and different manufacturers' standards, Instrument Displays, Inc., does not normally supply mating connectors with units.

B. Recommended Mating Connectors

1. Units without built-in Power Supply.
   a. 2 and 3 decades..double sided 12 pos. (24 contacts) with .156 contact centers.
   b. 4 decades.. double sided 15 position (30 contacts) with .156 contact spacing.
   c. 5 decades.. double sided 18 position (36 contacts) with .156 contact centers.
   d. 6 decades.. double sided 22 position (44 contacts) with .156 contact centers.
   e. 7 decades.. double sided 25 position (50 contacts) with .156 contact centers.
   f. 8 decades.. Winchester 8 BD28S or equivalent.
   g. 9 decades.. Winchester 8 BD30S or equivalent.

*Polarity option is considered a decade.

2. Units with Built-in Power Supply.
   a. 2,3 and 4 decades..Viking 3VH22/iCN5 or equivalent.
   b. 5-6 decades.. Winchester 8BD28S or equivalent.

*Polarity option is considered a decade.

C. Position Numbering

1. Because there are many manufacturers of PC card edge connectors, but not any one accepted numbering system; Instrument Displays, Inc., has adopted the following number system as a standard:

   As the unit is viewed from the rear, Pin #1 is the left most Pin on the top (component) side of the PC boards and numbered sequentially to the right until "N" where "N" is the number of contacts per side. The Pin under Pin 1 is numbered (N+1) and sequentially numbered to 2N along the bottom side of the Printed Circuit board.

D. Decade Numbering

As the digital display is viewed from the front, the right most decade is decade #1. This the least significant decade of display. All logic and display inputs to this decade are suffixed with 1. All logic and display inputs for the next decade are suffixed 2, etc. When polarity option is ordered, it normally occupies the location of the most significant decade, and uses the logic input pins for that decade as described in section E, part 10.

E. Pin connections
Notes are found on the last page of this section (Part II)

1. Two and three decade models without built-in power supply.

TOP	BOTTOM
Pin 1 ------200 VDC (1)	Pin 13 ------BCD Strobe (2)
Pin 2 ------Count input (2)	Pin 14 ------Logic 4-1
Pin 3 ------Memory -1 (3)	Pin 15 ------Logic 1-1
Pin 4 ------Decimal Point -1	Pin 16 ------Logic 2-1
Pin 5 ------Memory -2 (3)	Pin 17 ------Logic 8-1
Pin 6 ------Logic -2	Pin 18 ------Logic 1-2
Pin 7 ------Decimal Point -2	Pin 19 ------Logic 2-2
Pin 8 ------Memory -3 (3)	Pin 20 ------Logic 8-2
Pin 9 ------Logic 4-3	Pin 21 ------Logic 1-3
Pin 10------Decimal Point -3	Pin 22 ------Logic 2-3
Pin 11------5VDC input	Pin 23 ------Logic 8-3
Pin 12------Common Ground	Pin 24 ------Reset (2)

Note: On 2 decade models, omit connections for decade #3.

2. 4 decade models without Power Supply.

TOP	BOTTOM
Pin 1 ----+200 VDC (1)	Pin 16 ----Logic 4-1
Pin 2 ----Count Input (2)	Pin 17 ----Logic 1-1
Pin 3 ----Memory (3)	Pin 18 ----Logic 2-1
Pin 4 ----Decimal Point -1	Pin 19 ----Logic 8-1
Pin 5 ----BCD Strobe (2)	Pin 20 ----Logic 4-2
Pin 6 ----Memory -2 (3)	Pin 21 ----Logic 1-2
Pin 7 ----Decimal Point -2	Pin 22 ----Logic 2-2
Pin 8 ----Memory -3 (3)	Pin 23 ----Logic 8-2
Pin 9 ----Logic 4-3	Pin 24 ----Logic 1-3
Pin 10----Decimal Point -3	Pin 25 ----Logic 2-3
Pin 11----Memory -4 (3)	Pin 26 ----Logic ~~4-3~~ 8-3
Pin 12----Logic 4-4	Pin 27 ----Logic 1-4
Pin 13----Decimal Point -4	Pin 28 ----Logic 2-4
Pin 14----+5VDC	Pin 29 ----Logic 8-4
Pin 15----Common Ground	Pin 30 ----Reset (2)

3. 5 Decade units without Built-In Power Supply.

Pin 1 ----+200 VDC (1)
Pin 2 ----Count input (2)
Pin 3 ----Logic 4-1
Pin 4 ----Memory -1 (3)
Pin 5 ----Decimal Point -1
Pin 6 ----Memory -2 (3)
Pin 7 ----Decimal Point -2
Pin 8 ----BCD strobe (2)
Pin 9 ----Memory -3 (3)
Pin 10----Decimal Point -3
Pin 11----Memory -4 (3)
Pin 12----Logic 4-4
Pin 13----Decimal Point -4
Pin 14----Memory -5
Pin 15----Logic 4-5
Pin 16----Decimal Point -5
Pin 17----+5VDC
Pin 18----Common Ground

Pin 19 ----Logic 1-1
Pin 20 ----Logic 2-1
Pin 21 ----Logic 8-1
Pin 22 ----Logic 4-2
Pin 23 ----Logic 1-2
Pin 24 ----Logic 2-2
Pin 25 ----Logic 8-2
Pin 26 ----Logic 4-3
Pin 27 ----Logic 1-3
Pin 28 ----Logic 2-3
Pin 29 ----Logic 8-3
Pin 30 ----Logic 1-4
Pin 31 ----Logic 2-4
Pin 32 ----Logic 8-4
Pin 33 ----Logic 1-5
Pin 34 ----Logic 2-5
Pin 35 ----Logic 8-5
Pin 36 ----Reset (2)

4. 6 Decade units without Built-In Power Supply.

TOP

Pin 1 ----+200VDC (1)
Pin 2 ----Logic 4-1
Pin 3 ----Count Input (2)
Pin 4 ----Memory -1 (3)
Pin 5 ----Decimal Point -2
Pin 6 ----Memory -2 (3)
Pin 7 ----Decimal Point -2
Pin 8 ----Memory -3 (3)
Pin 9 ----Logic 4-3
Pin 10----Decimal Point -3
Pin 11----Memory -4 (3)
Pin 12----Logic 4-4
Pin 13----Decimal Point -4
Pin 14----No Connection
Pin 15----BCD Strobe (2)
Pin 16----Memory -5 (3)
Pin 17----Decimal Point -5
Pin 18----Memory -6 (3)
Pin 19----Logic 4-6
Pin 20----Decimal Point -6
Pin 21----+5VDC
Pin 22----Common Ground

BOTTOM

Pin 23 ----No Connection
Pin 24 ----Logic 1-1
Pin 25 ----Logic 2-1
Pin 26 ----Logic 8-1
Pin 27 ----Logic 4-2
Pin 28 ----Logic 1-2
Pin 29 ----Logic 2-2
Pin 30 ----Logic 8-2
Pin 31 ----Logic 1-3
Pin 32 ----Logic 2-3
Pin 33 ----Logic 8-3
Pin 34 ----Logic 1-4
Pin 35 ----Logic 2-4
Pin 36 ----Logic 8-4
Pin 37 ----Logic 4-5
Pin 38 ----Logic 1-5
Pin 39 ----Logic 2-5
Pin 40 ----Logic 8-5
Pin 41 ----Logic 1-6
Pin 42 ----Logic 2-6
Pin 43 ----Logic 8-6
Pin 44 ----Reset (2)

5. 7 Decade units without Built-In Power Supply.

PIN 1 ---- +200VDC (1)
Pin 2 ---- Count Input (2)
Pin 3 ---- Logic 4-1
Pin 4 ---- Memory -1 (3)
Pin 5 ---- Decimal Point -1
Pin 6 ---- Memory -2 (3)
Pin 7 ---- Decimal Point -2
Pin 8 ---- Memory -3 (3)
Pin 9 ---- Logic 4-3
Pin 10---- Decimal Point -3
Pin 11---- Logic 4-4
Pin 12---- Memory -4 (3)
Pin 13---- Decimal Point -4
Pin 14---- BCD Strobe (2)
Pin 15---- Memory -5 (3)
Pin 16---- Decimal Point -5
Pin 17---- No Connection
Pin 18---- Memory -6 (3)
Pin 19---- Logic 4-6
Pin 20---- Decimal Point -6
Pin 21---- Memory -7
Pin 22---- Logic4-7
Pin 23---- Decimal Point -7
Pin 24---- +5VDC
Pin 25---- GND

PIN 26 ----No connection
Pin 27 ----Logic 1-1
Pin 28 ----Logic 2-1
Pin 29 ----Logic 8-1
Pin 30 ----Logic 4-2
Pin 31 ----Logic 1-2
Pin 32 ----Logic 2-2
Pin 33 ----Logic 8-2
Pin 34 ----Logic 1-3
Pin 35 ----Logic 2-3
Pin 36 ----Logic 8-3
Pin 37 ----Logic 1-4
Pin 38 ----Logic 2-4
Pin 39 ----Logic 8-4
Pin 40 ----Logic 4-5
Pin 41 ----Logic 1-5
Pin 42 ----Logic 2-5
Pin 43 ----Logic 8-5
Pin 44 ----Logic 1-6
Pin 45 ----Logic 2-6
Pin 46 ----Logic 8-6
Pin 47 ----Logic 1-7
Pin 48 ----Logic 2-7
Pin 49 ----Logic 8-7
Pin 50 ----Reset (2)

6. 8 Decade Display

TOP	BOTTOM
Pin 1 ---- +200VDC (1)	Pin 29 ----Logic 1-1
Pin 2 ---- Count Input (2)	Pin 30 ----Logic 2-1
Pin 3 ---- Logic 4-1	Pin 31 ----Logic 8-1
Pin 4 ---- Memory -1 (3)	Pin 32 ----Logic 4-2
Pin 5 ---- Decimal Point -1	Pin 33 ----Logic 1-2
Pin 6 ---- Memory -2 (3)	Pin 34 ----Logic 2-2
Pin 7 ---- Decimal Point -2	Pin 35 ----Logic 8-2
Pin 8 ---- Memory -3 (2)	Pin 36 ----Logic 4-3
Pin 9 ---- Decimal Point 3	Pin 37 ----Logic 1-3
Pin 10---- N/C	Pin 38 ----Logic 2-3
Pin 11---- N/C	Pin 39 ----Logic 8-3
Pin 12---- Logic 4-4	Pin 40 ----Logic 1-4
Pin 13---- Memory -4 (3)	Pin 41 ----Logic 2-4
Pin 14---- Decimal Point -4	Pin 42 ----Logic 8-4
Pin 15---- Logic 4-5	Pin 43 ----Logic 1-5
Pin 16---- Memory -5 (3)	Pin 44 ----Logic 2-5
Pin 17---- Decimal Point -5	Pin 45 ----Logic 8-5
Pin 18---- BCD Strobe (3)	Pin 46 ----Logic 4-6
Pin 19---- Memory -6 (3)	Pin 47 ----Logic 1-6
Pin 20---- Decimal Point 6	Pin 48 ----Logic 2-6
Pin 21---- Memory -7 (3)	Pin 49 ----Logic 8-6
Pin 22---- Logic 4-7	Pin 50 ----Logic 1-7
Pin 23---- Decimal Point 7	Pin 51 ----Logic 2-7
Pin 24---- Memory -8 (3)	Pin 52 ----Logic 8-7
Pin 25---- Logic 4-8	Pin 53 ----Logic 1-8
Pin 26---- Decimal Point 8	Pin 54 ----Logic 2-8
Pin 27---- +5VDC	Pin 55 ----Logic 8-8
Pin 28---- GND	Pin 56 ----Reset (2)

7. 9 Decade Displays.

Pin 1 ----+200VDC (1)
Pin 2 ____Count in (2)
Pin 3 ----Logic 4-1
Pin 4 ----Memory -1 (3)
Pin 5 ----Decimal Point 1
Pin 6 ----Logic 4-2
Pin 7 ----Memory 4-2 (3)
Pin 8 ----Decimal Point 2
Pin 9 ----Logic 4-3
Pin 10----Memory -3 (3)
Pin 11----Decimal Point 3
Pin 12----Memory -4 (3)
Pin 13----Decimal Point 4
Pin 14----Logic 4-5
Pin 15----Memory -5 (3)
Pin 16----Decimal Point 5
Pin 17----Logic 4-6
Pin 18----Memory -6 (3)
Pin 19----Decimal Point 6
Pin 20----BCD Strobe (2)
Pin 21----Memory -7 (3)
Pin 22----Decimal Point 7
Pin 23----Memory -8 (3)
Pin 24----Logic 4-8
Pin 25----Decimal Point 8
Pin 26----Memory -9 (3)
Pin 27----Logic 4-9
Pin 28----Decimal Point 9
Pin 29----+5VDC'
Pin 30----GND

Pin 31 ----Logic 1-1
Pin 32 ----Logic 2-1
Pin 33 ----Logic 8-1
Pin 34 ----Logic 1-2
Pin 35 ----Logic 2-2
Pin 36 ----Logic 8-2
Pin 37 ----Logic 1-3
Pin 38 ----Logic 2-3
Pin 39 ----Logic 8-3
Pin 40 ----Logic 4-4
Pin 41 ----Logic 1-4
Pin 42 ----Logic 2-4
Pin 43 ----Logic 8-4
Pin 44 ----Logic 1-5
Pin 45 ----Logic 2-5
Pin 46 ----Logic 8-5
Pin 47 ----Logic 1-6
Pin 48 ----Logic 2-6
Pin 49 ----Logic 8-6
Pin 50 ----Logic 4-7
Pin 51 ----Logic 1-7
Pin 52 ----Logic 2-7
Pin 53 ----Logic 8-7
Pin 54 ----Logic 1-8
Pin 55 ----Logic 2-8
Pin 56 ----Logic 8-8
Pin 57 ----Logic 1-9
Pin 58 ----Logic 2-9
Pin 59 ----Logic 8-9
Pin 60 ----Reset (2)

8. 2, 3, and 4 decade models with Built-In Power supply.

Pin 1 ----N/C
Pin 2 ----N/C
Pin 3 ----N/C
Pin 4 ----N/C
Pin 5 ----Logic 4-1
Pin 6 ----Decimal Point 1
Pin 7 ----Logic 1-1
Pin 8 ----Memory -2 (3)
Pin 9 ----KEY
Pin 10----N/C
Pin 11----Memory -3 (3)
Pin 12----Z43
Pin 13----Z13
Pin 14----N/C
Pin 15----AC Power Line
Pin 16----AC Power Line
Pin 17----BCD Strobe (2)
Pin 18----Memory 4 (3)
Pin 19----Z44
Pin 20----Z14
Pin 21----GROUND
Pin 22----N/C
Pin 23 ----N/C
Pin 24 ----Reset (2)
Pin 25 ----Logic 2-1
Pin 26 ----8-1
Pin 27 ----Memory -1 (3)
Pin 28 ----Z42
Pin 29 ----Z12
Pin 30 ----Z22
Pin 31 ----KEY
Pin 32 ----Z82
Pin 33 ----Decimal Point 2
Pin 34 ----N/C
Pin 35 ----N/C
Pin 36 ----N/C
Pin 37 ----N/C
Pin 38 ----Z23
Pin 39 ----Z83
Pin 40 ----Decimal Point 3
Pin 41 ----Z24
Pin 42 ----Z84
Pin 43 ----Count-In (2)
Pin 44 ----Decimal Point 4

Note: When a two decade unit is built in, this configuration, decades one and four, are omitted and decade #2 becomes the least significant.

When a three decade unit is built, decade #4 is omitted.

Z41 = Logic 4 of decade No 1, etc.

9. 5, and 6 decade units with built in Power Supply.

TOP	BOTTOM
Pin 1 ----No Connection	Pin 29 -----No Connection
Pin 2 ----No Connection	Pin 30 -----No Connection
Pin 3 ----Reset (2)	Pin 31 -----Count-in (2)
Pin 4 ----Ground	Pin 32 -----No Connection
Pin 5 ----No Connection	Pin 33 -----Logic 4-1
Pin 6 ----Logic 1-1	Pin 34 -----Logic 2-1
Pin 7 ----Logic 8-1	Pin 35 -----Memory -1 (3)
Pin 8 ----Decimal Point -1	Pin 36 -----Logic 1-2
Pin 9 ----Logic 2-2	Pin 37 -----Logic 4-2
Pin 10----No Connection	Pin 38 -----Logic 8-2
Pin 11----No Connection	Pin 39 -----Decimal Point -2
Pin 12----Ground	Pin 40 -----Memory -2 (3)
Pin 13----+5VDC	Pin 41 -----Logic 1-3
Pin 14----Logic 8-3	Pin 42 -----Logic 2-3
Pin 15----N/C	Pin 43 -----No Connection
Pin 16----N/C	Pin 44 -----Memory -3 (3)
Pin 17----Logic 4-3	Pin 45 -----Decimal Point -3
Pin 18----BCD Strobe (2)	Pin 46 -----Logic 1-4
Pin 19----Logic 2-4	Pin 47 -----Logic 4-4
Pin 20----Memory -4 (3)	Pin 48 -----AC Power Line
Pin 21----Decimal Point 4	Pin 49 -----Logic 8-4
Pin 22----No Connection	Pin 50 -----AC Power Line
Pin 23----Logic 1-5	Pin 51 -----Logic 4-5
Pin 24----Decimal Point -5	Pin 52 -----Logic 2-5
Pin 25----Logic 1-6	Pin 53 -----Logic 8-5
Pin 26----Logic 2-6	Pin 54 -----Memory -5 (3)
Pin 27----Memory -6 (3)	Pin 55 -----Logic 4-6
Pin 28----Decimal Point -6	Pin 56 -----Logic 8-6

Note: When 5 decade units are built in this configuration, omit pin connections for decade #6.

10. Polarity Connections

The Polarity input is a one line signal where logic "1" = plus, logic "0" = minus. Information is brought in on the logic Z pin of the decade it replaces.

The Polarity output is also a one line signal and is brought out on the logic 4 line of the replaced decade.

The Polarity option always has memory, and is connected to the memory line of the replaced decade.

There are no connections to logic 1, 8 of the replaced decade.

11. Notes:

(1) On seven segmented models, this pin is "lamp test". Grounding will turn on all segments. DO NOT connect 200 volts on other than "Nixie" displays.

(2) Used on counters, and counter/memory units only.

(3) Used only on models with memory.

VI. Operating The Unit

A. Display and display with memory models.

Applying proper power and positive true BCD input information onto the correct pins will produce a decimal display equivalent to the BCD coded information. On models with memory, grounding the memory gate lines will disable the input lines and the display will continue to show whatever was at the input pins at the time the memory gate was grounded. If a decimal point is required, it can be turned on by grounding the appropriate pin.

B. Counter and counter with memory models.

If a pulse train is supplied to the count input terminal, the display will index by 1 each time the signal transits from a logic "1" (high) to logic "0" (Low) as defined in Section II. The display can be reset to all zeroes by applying a high to the pin marked "Reset". It should be noted that this pin is the input of a TTL integrated circuit and if left unconnected, it will "Float" at logic 1 or in the reset mode. In order to Make a unit count, it will be necessary to apply a logic "0" or ground the pin marked reset. Buffered BCD output for each decade is brought out on the logic pins. A low on the BCD strobe will cause the BCD outputs to go to all zeroes.

On the counter with memory, a low applied to the memory gate line, will cause the BCD output and information to be "Latched" at whatever information was in the counters at the time the memory line went low. The counters will continue to count the pulses even though the display will not indicate the change. A decimal point can be turned on by grounding the appropriate pin.

VII. In Case of Trouble

The purpose of this section is to aid the customer in determining which of the major components is faulty. Any functional problem that can not be solved by replacing a plug in card should be referred to the factory. Failure to do so will void the warranty.

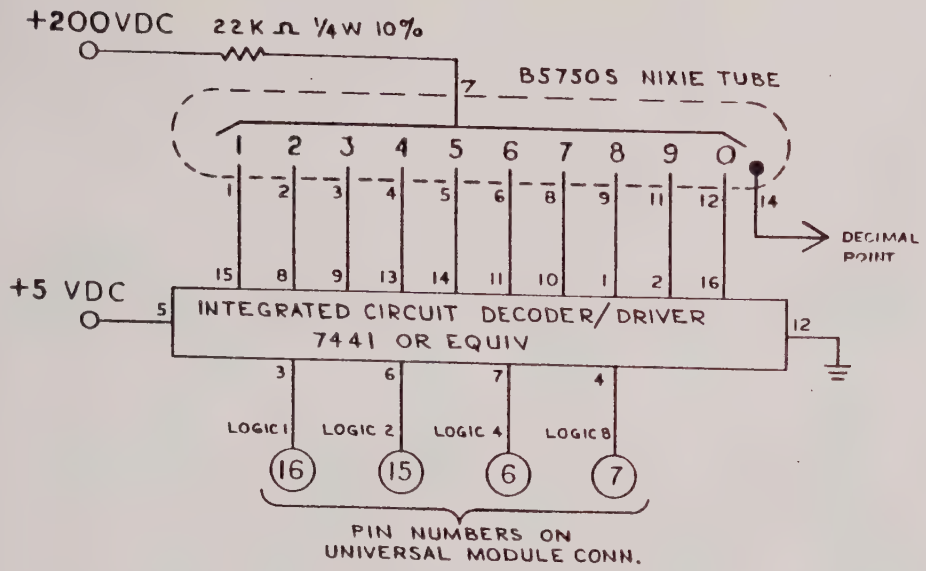
Check all edge connector wiring. Be certain that all voltages are applied to the correct terminal. Refer to the Electrical Specifications (Section II) for the correct pulse widths and levels for each input.

If the problem is confined to one decade, interchange module cards to determine if the card or decoder/display section is at fault. On counter units, a faulty card in the first decade could cause the unit not to count. Interchange the first and second decade counter cards in order to isolate the problem. A faulty counter card could also interfere with the resetting of all decades. Remove the cards one at a time to isolate the faulty card.

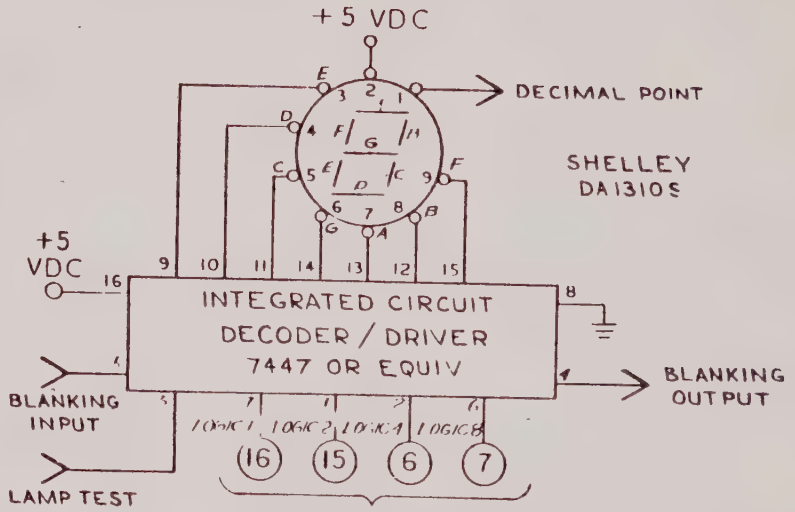
If you still have difficulty, contact the factory for further assistance.

WARRANTY

All components are guaranteed to be free from defects in workmanship and materials for a period of one year from date of shipment.

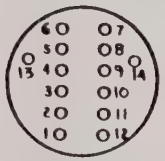


"M" SERIES
NIXIE

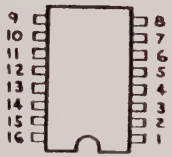


"S" SERIES
SEVEN SEGMENT INCANDESCENT

DECODER/DRIVER CIRCUITRY

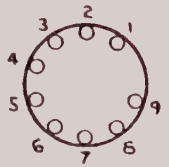


NIXIE TUBE



INTEGRATED CIRCUIT

UNIVERSAL MODULE CONNECTOR



SEVEN SEGMENT INCANDESCENT

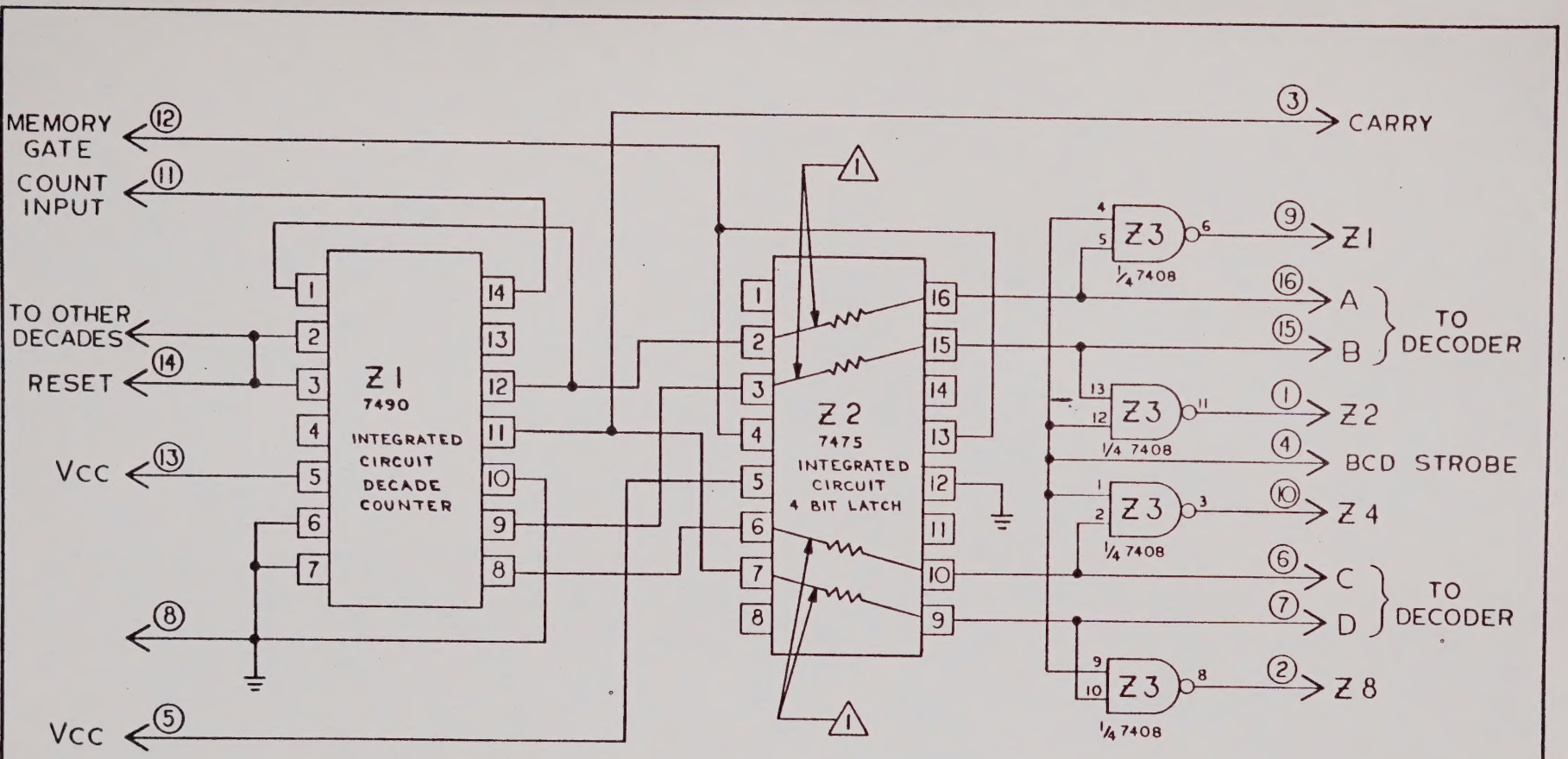
BASE DIAGRAMS
(ALL TOP VIEWS)

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
MACHINE FINISHES
TOLERANCES ON
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±
FINISH
MATERIAL

INSTRUMENT DISPLAYS INC.
A SUBSIDIARY OF
KELTRON CORPORATION

DI CODER/DRIVER
CIRCUITRY

DR JJ
DATE 2-12-72
APPD
DATE
CHK
DATE
SCALE
DRAWING NUMBER



NOTES:

1. ON UNITS WITHOUT MEMORY, 10 OHM RESISTORS ARE INSTALLED IN PLACE OF Z2
2. NUMBERS IN CIRCLES REFER TO PIN NUMBERS ON UNIVERSAL MODULE CONNECTOR

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
MACHINE FINISHES ✓
TOLERANCES ON
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±
FINISH
MATERIAL

INSTRUMENT DISPLAYS INC.
A SUBSIDIARY OF
KELTRON CORPORATION

UNIVERSAL COUNTER MODULE

DR JF DATE 2-12-72 APPD DATE
CHK DATE SCALE
DRAWING NUMBER